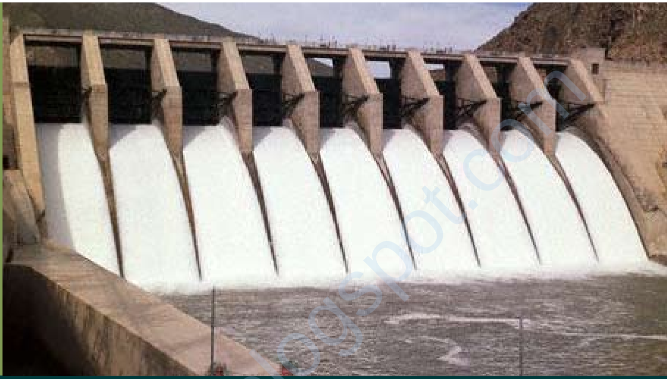
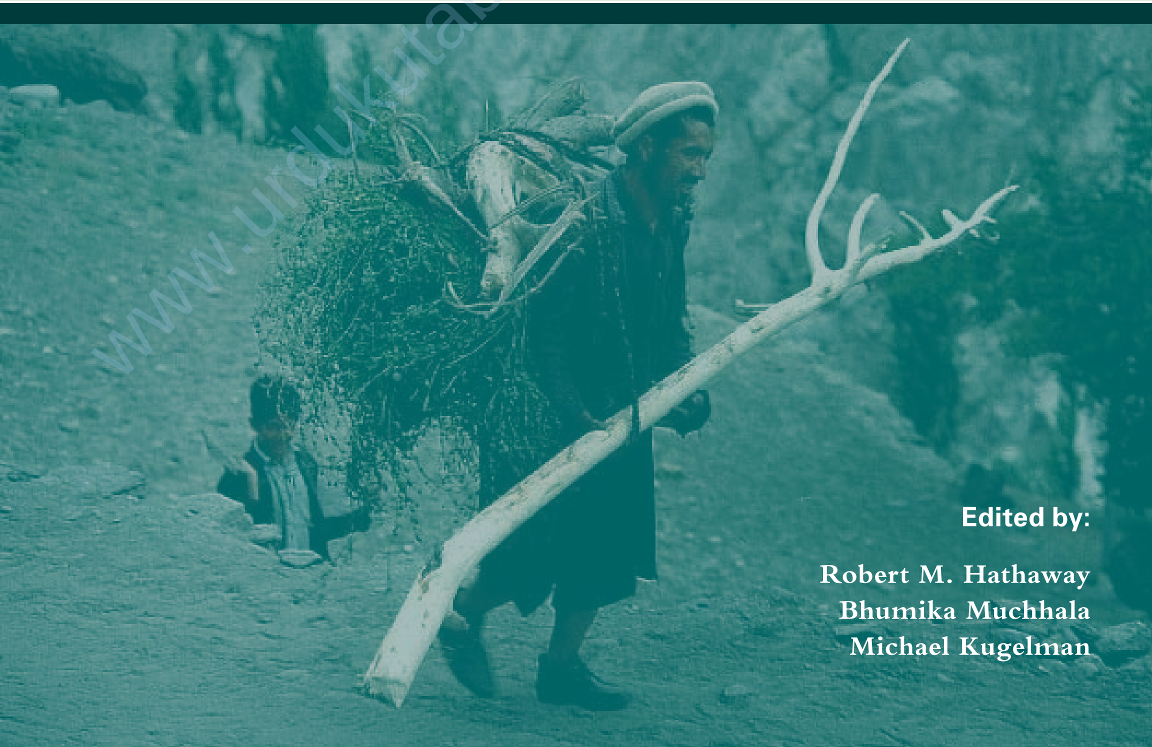
Woodrow Wilson
International
Center
for Scholars
Asia Program



FUELING THE FUTURE:

Meeting Pakistan's Energy Needs in the 21st Century



Edited by:

Robert M. Hathaway
Bhumika Muchhala
Michael Kugelman

FUELING THE FUTURE:

Meeting Pakistan’s Energy Needs in the 21st Century

اردو کتب خانہ
URDUKUTABKHANAPK.BLOGSPOT

اردو کتب خانہ

URDUKUTABKHANAPK.BLOGSPOT

Woodrow Wilson International Center for Scholars
Asia Program

FUELING THE FUTURE:

Meeting Pakistan's Energy Needs in the 21st Century

Essays by:

Mukhtar Ahmed
Saleem H. Ali
Shahid Javed Burki
John R. Hammond
Dorothy Lele
Robert Looney
Sanjeev Minocha
Bikash Pandey
Sabira Qureshi
Asad Umar
Vladislav Vucetic and Achilles G. Adamantiades
Aram Zamgochian

Edited by:

Robert M. Hathaway
Bhumika Muchhala
Michael Kugelman

March 2007

Woodrow Wilson
International
Center
for Scholars

Available from :

Asia Program
Woodrow Wilson International Center for Scholars
One Woodrow Wilson Plaza
1300 Pennsylvania Avenue NW
Washington, DC 20004-3027

www.wilsoncenter.org

ISBN 1-933549-17-3

Cover photos: Water Rushes Through the Warsak Dam, Pakistan, © Paul Almasy/CORBIS; Woodcutter in Hunza Valley, © Robert Holmes/CORBIS

The Woodrow Wilson International Center for Scholars, established by Congress in 1968 and headquartered in Washington, D.C., is a living national memorial to President Wilson. The Center's mission is to commemorate the ideals and concerns of Woodrow Wilson by providing a link between the worlds of ideas and policy, while fostering research, study, discussion, and collaboration among a broad spectrum of individuals concerned with policy and scholarship in national and international affairs. Supported by public and private funds, the Center is a nonpartisan institution engaged in the study of national and world affairs. It establishes and maintains a neutral forum for free, open, and informed dialogue. Conclusions or opinions expressed in Center publications and programs are those of the authors and speakers and do not necessarily reflect the views of the Center staff, fellows, trustees, advisory groups, or any individuals or organizations that provide financial support to the Center.

The Center is the publisher of *The Wilson Quarterly* and home of Woodrow Wilson Center Press, *dialogue* radio and television, and the monthly news-letter "Centerpoint." For more information about the Center's activities and publications, please visit us on the web at www.wilsoncenter.org.

Lee H. Hamilton, President and Director

Board of Trustees
Joseph B. Gildenhorn, Chair
David A. Metzner, Vice Chair
Public members: James H. Billington, Librarian of Congress; John W. Carlin, Archivist of the United States; Bruce Cole, Chair, National Endowment for the Humanities; Michael O. Leavitt, Secretary, U.S. Department of Health and Human Services; Tamala L. Longaberger, designated appointee within the Federal Government; Condoleezza Rice, Secretary, U.S. Department of State; Lawrence M. Small, Secretary, Smithsonian Institution; Margaret Spellings, Secretary, U.S. Department of Education; Allen Weinstein, Archivist of the United States
Private Citizen Members: Robin Cook, Donald E. Garcia, Bruce S. Gelb, Sander R. Gerber, Charles L. Glazer, Susan Hutchinson, Ignacio E. Sanchez

CONTENTS

3 **Glossary**

5 **Introduction**
Robert M. Hathaway

17 **Meeting Pakistan's Energy Needs**
Mukhtar Ahmed

35 **The Weight of History: Pakistan's Energy Problem**
Shahid Javed Burki

57 **Energy, Poverty Reduction and Equitable Development in Pakistan**
Sabira Qureshi

79 **Social and Gender Issues in Pakistan's Energy Sector**
Dorothy Lele

93 **Energy and the Pakistani Economy: An Exploratory Analysis to 2035**
Robert Looney

105 **Power Sector Reform in Pakistan: Issues and Challenges**
Vladislav Vucetic and Achilles G. Adamantiades

133 **Promoting Private Sector Participation in Oil and Gas Projects—A Financing Perspective**
Sanjeev Minocha

141 **The Role of the Private Sector in Pakistan's Energy Sector**
Asad Umar

149 **The Role of the U.S. Private Sector in Meeting Pakistan's Energy Requirements**
John R. Hammond

157 **U.S. Chamber of Commerce Energy Overview for the Islamic Republic of Pakistan**
Aram Zamgochian

167 **Clean Energy Options for Rural Pakistan: Lessons from South Asia**
Bikash Pandey

185 **Resolving Environmental Conflicts in Pakistan's Energy Policy**
Saleem H. Ali

201 **Recent Asia Program Publications**

GLOSSARY

AEDB	Alternative Energy Development Board
BSP	Biogas Support Program (Nepal)
Btu	British thermal unit
CCGT	Combined cycle gas turbine
CHASNUPP	Chasma Nuclear Power Plant
c-km	Circuit-kilometers
CNG	Compressed natural gas
CPPA	Central Power Purchasing Agency
DISCOs	Electricity distribution companies
E&P	Exploration and production
ESMAP	Energy Sector Management Assistance Project
FDI	Foreign direct investment
FY	Fiscal year
GDP	Gross domestic product
GEF	Global Environment Facility
GENCOs	Thermal generation companies
GS	Grameen Shakti
GW	Gigawatts
GWh	Gigawatt hour
HESS	Pakistan Household Energy Strategy Study
Hydel	hydroelectric
IMF	International Monetary Fund
IPPs	Independent power producers
KANUPP	Karachi Nuclear Power Plant
KESC	Karachi Electric Supply Corporation
Ktoe	Kiloton of oil equivalent
kV	Kilovolt
KWh	Kilowatt-hour

LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MDG	Millennium Development Goals
MMcf	Million cubic feet
MMscfd	Million standard cubic feet per day
MTOE	Million tons of oil equivalent
mtpa	Million tons per annum
MVA	Megavolt-amperes
MW	Megawatt
MWe	Megawatt (electrical)
NEPRA	National Electric Power Regulatory Authority
NGO	Nongovernmental organization
NTDC	National Transmission and Dispatch Company
NWFP	Northwest Frontier Province
PAEC	Pakistan Atomic Energy Commission
PEPCO	Pakistan Electric Power Company
PPA	Power purchase agreement
PPIB	Private Power and Infrastructure Board
PPP	Purchasing power parity
PV	Photo voltaic
RE	Renewable energy
REDCO	Regional electricity distribution company
RERED	Renewable Energy for Rural Economic Development (Sri Lanka)
RETs	Renewable energy technologies
Rs.	Rupees
TOE	Tons of oil equivalent
WAPDA	Water and Power Development Authority
WPPO	WAPDA Power Privatization Organization

INTRODUCTION

ROBERT M. HATHAWAY

*Pakistan's development vision for an expanded economy, increased industrialization, and elevated standards of living will demand enormous amounts of energy; and the links between **sustainable development and energy** will require major efforts for long term energy security."*

—Pakistan Planning Commission[1]

Pakistan's economy is growing, and with this growth comes higher energy consumption and greater pressure on the country's energy resources. At present, demand for energy exceeds supply, and power outages and planned power cuts (euphemistically termed "load-shedding") are common. In addition to the economic costs, energy shortages can foster political instability. June 2006 saw angry public protests in Karachi and riots in Liaquatabad over repeated power failures. A widespread power outage across much of the country three months later triggered panicky rumors of a coup. This unrest may be only a foretaste of things to come. Absent drastic action, Pakistan's energy situation is expected to get worse in the years ahead.

Today, oil and natural gas supply the bulk (roughly 79 percent) of Pakistan's energy needs. However, the consumption of those energy sources vastly exceeds the indigenous supply. For instance, Pakistan currently produces only 19.9 percent of the oil it consumes, fostering a dependency on imports that places considerable strain on the country's financial position. While the present situation with respect to natural gas production is not nearly as serious, Pakistan's projected natural gas needs are expected almost to double (from 2004 levels) by 2010.

On the other hand, hydropower and coal are perhaps underutilized today, as Pakistan has ample potential supplies of both, at a time when

---

Robert M. Hathaway is director of the Asia Program at the Woodrow Wilson International Center for Scholars.

these resources provide for relatively little (a combined total of 20 percent) of Pakistan's energy needs. Pakistan's proven coal reserves are the world's sixth largest, and the Pakistani government intends to increase the share of coal in the overall energy mix from 7 to 18 percent by 2018—a course that may make sense from an energy standpoint, but which carries troubling environmental implications. Meanwhile, widespread public opposition has significantly slowed the government's plans to build dams capable of generating electricity.

Nuclear power at this point accounts for only 1 percent of Pakistan's energy consumption. Pakistan has two civilian-use nuclear reactors, while construction on a third began in 2006. The present government has announced plans for Pakistan to develop a generating capability of 8,800 megawatts (MW) of nuclear energy by 2020, compared to the country's current output of less than 450 MW. Pakistan has denied press reports that it is negotiating with China to buy six to eight additional reactors. But Islamabad has urged the United States and other western countries to help it develop civilian nuclear technology to meet its growing energy needs, an idea certain to meet with resistance in the West.

Pakistan's minister for petroleum and natural resources has identified energy as the most important input for the country's economic development. The uninterrupted supply of energy to fuel the nation's economy, he has declared, should be the highest priority for the country's economic managers. Salman Shah, a senior official in Pakistan's finance ministry and adviser to the prime minister on finance and revenue, has underscored Pakistan's intent to ensure energy security with talk about positioning the country as "a new energy hub for the region."

The need to address Pakistan's present and prospective energy requirements was a topic of discussion during President George W. Bush's March 2006 visit to Pakistan. The joint statement issued by the U.S. and Pakistani presidents at the conclusion of the Bush trip committed the two countries to holding a high-level energy meeting "to inaugurate an energy working group, which will explore ways to meet Pakistan's growing energy needs and strengthen its energy security," and to working together "to develop public and private collaboration on a broad range of energy sources."

On June 23, 2006, the Woodrow Wilson International Center for Scholars hosted a day-long conference, organized by the Center's Asia

Program, to look at Pakistan's energy needs over the next 25–30 years, and to foster informed discussion on how Pakistan might succeed in meeting its energy requirements in the decades ahead. Conference participants were invited to consider what steps—by the Pakistani government, Pakistan's private sector, foreign investors, and the international financial institutions—might be taken today so that Pakistan will be prepared to meet its energy needs tomorrow. Many of the essays printed here were first written for that conference. Others were solicited after the conference for inclusion in this collection.

In the volume's opening essay, **Mukhtar Ahmed**, energy adviser to the Pakistani prime minister, explores the energy challenges facing Pakistan and lays out the energy policies of the current Pakistani government. Observing that 40 percent of Pakistani households are not even connected to the electrical grid, Ahmed warns that over the next 20 years, the country's overall demand for energy will increase by 350 percent. During this period, the percentage of Pakistan's total energy needs met from domestic sources will fall from 72 to 38 percent. Ahmed writes of the need to develop an integrated energy development plan combining energy imports, the development of indigenous energy resources, a more diversified energy mix, and programs emphasizing greater energy efficiency and better management. In the near term, gas imports via pipeline can deliver energy at competitive prices. The government gives a high priority to tapping the energy resources of Pakistan's neighbors, Ahmed asserts; several projects for the import of natural gas from the Middle East and Central Asia and of power from Tajikistan and Kyrgyzstan are under consideration. Moving from the near to the medium term, Pakistan will need to develop the rich coal deposits of the Thar desert, as well as nuclear power. The "cornerstone" of the government's long-range policy, Ahmed states, involves a shift from a predominantly state-controlled industry to an arrangement where the private sector plays a leading role in the development and management of the country's energy program.

Shahid Javed Burki, for many years a senior World Bank official who also served briefly as finance minister of Pakistan, provides a historical context in which to place Pakistan's current challenges. For nearly six decades, he writes, no Pakistani government made a serious effort to prepare for the country's energy requirements. As a consequence, Pakistan has been saddled with "weak institutions, inappropriate pricing policies and insufficient public sector investment." The net result, Burki observes, citing the government's own figures, is that by 2030, energy demand in Pakistan will be almost 64 percent greater than projected supply. Unless Pakistan moves to address this shortfall, he warns, the country will inevitably pay a large cost not only in an economic sense, but also in terms of a rise in Islamic extremism and slower progress toward political democracy.

Burki criticizes the Pervez Musharraf government for resorting to ad hoc measures to deal with Pakistan's energy needs and for failing to address deep-rooted structural problems in the energy sector. The government's so-called strategy for placing the country on a sustainable path of development is, in fact, "no more than a long wish-list of projects and intentions." Pakistan must develop a "comprehensive strategy" for meeting its energy needs over the next quarter century. Such a strategy would offer realistic approaches for addressing the widening energy supply-demand gap and, among many other things, would require greater political will than the government has displayed to date to overcome resistance to the construction of the dams that will enable the country to exploit its enormous hydroelectric potential. Burki also places considerable emphasis on the development and exploitation of new technologies, such as those that could turn cellulose into energy, as a means for Pakistan to meet its coming energy requirements.

Several of the contributors to this volume emphasize that a lack of access to modern energy services is inextricably linked to poverty and to a country's failure to meet the basic needs of its people, including food, shelter, health care, and education. **Sabira Qureshi** looks at the links between energy policy and poverty reduction efforts, and asks how energy policy and energy programs can be better leveraged to address the challenge of reducing Pakistan's high poverty rates. Study after study, Qureshi writes, has demonstrated that a lack of access to modern energy supplies inhibits the ability of the poor, particularly the rural poor, to escape from poverty. Yet in Pakistan, as elsewhere in the developing world, energy policy is "disproportionately oriented towards the elite rather than the poor." Those responsible for formulating Pakistan's energy policy, Qureshi laments, "continue to concentrate on meeting the country's rapidly growing energy needs in the formal sector, while failing to respond to poverty reduction needs, particularly as they relate to rural household consumption." And because the majority of Pakistan's poor are female, government energy policies must explicitly recognize the need "to mainstream gender" in all energy initiatives.

Dorothy Lele insists that social and human development should be the ultimate objective of Pakistan's energy policies, not just a fortunate by-product. The poor, she writes, usually pay a higher percentage of their income on energy, and much more per unit of "useful energy service" than the rich. (Qureshi cites a study that found that low-income rural households spend 21 percent of total household expenditures on fuel.) Modern energy services, Lele maintains, "can transform the lives of the poor by increasing the productivity of their labor, providing new employment opportunities, reducing the time spent in arduous tasks," and eliminating the damaging health effects of traditional cooking stoves.

Lele and Qureshi both stress the significance of biomass (primarily firewood, dung, and crop residues), noting that these materials comprise a substantial proportion of total energy consumption in Pakistan and are the primary household fuel in rural areas, irrespective of household income, and in low-income urban households. Most biomass energy is used by women for cooking. Given its importance for the majority of the population, Lele writes, and given the fact that biomass will play an essential role in energy use in Pakistan for many years to come, the exclusion of this form of energy from energy sector planning and programs and the lack of attention given to improved biomass use constitute serious shortcomings in Pakistan's current approach to energy. Lele readily concedes that the government needs to develop modern fuels, but asserts that this focus "neglects the barriers involved in their adoption by large segments of the population, and the urgent need for improving current damaging fuel-use practices."

Both Lele and Qureshi highlight the manner in which a lack of access to modern fuels reinforces Pakistan's gender divides. Energy poverty, Qureshi writes, "further marginalizes rural women and girls who spend a disproportionate amount of their time collecting fuel-wood and water," which leaves them with little opportunity to engage in more economically productive activities. "When women's labor is not valued," Lele adds, "the time and effort they spend on fuel collection and food preparation are not seen as important." Consequently, they find it difficult to draw attention to their plight. Lele asks whether the neglect of biomass in commercial energy planning is not linked to the predominance of women in biomass energy use.

Qureshi also highlights the situation in Baluchistan, the largest and least developed of Pakistan's four provinces, where an insurgency that has simmered for decades has recently become a more serious challenge to Islamabad. Baluchistan has vast reserves of natural gas, petroleum, and minerals, Qureshi notes, yet for all its wealth, 45 percent of the population lives below the poverty line. While its natural gas generates huge revenues for the central government, most of the province, except for a few cities, remains without access to natural gas, and Islamabad returns to the province only a tiny percentage of the revenues it receives from Baluchistan's natural gas. Baluchistan's grievances with Islamabad go far beyond energy issues, but the failure by a succession of central governments to ensure that the province receives benefits commensurate to its energy wealth has helped create a serious security problem for Pakistan.

Robert Looney, an economist and professor of national security affairs at the Naval Postgraduate School in Monterey, California, sets out seven "energy futures"—alternative scenarios of growth and energy needs, based on a macroenergy forecasting model that simulates different patterns and rates of investment and energy availabilities between now and 2035. The models attempt to predict how different investment/energy supply mixes will affect the overall economy. Looney's modeling suggests that an economic environment characterized by high rates of sustained investment and a major expansion of Pakistan's hydroelectric generation capacity is most likely to produce sustained economic growth, especially if supported by substantial loans from international agencies. The author is suitably modest in the predictive capabilities of his models. What takes place outside the energy sector, he cautions, may have consequences that are just as important for the country's energy future as policies directly targeted at the energy sector. True enough, yet it appears indisputable that choices in the energy sector made today will have a major impact on whether Pakistan succeeds in generating high GDP growth rates a generation hence.

The essay by **Vladislav Vucetic** and **Achilles G. Adamantiades**, both of the World Bank, focuses specifically on Pakistan's power sector, with particular emphasis on the status of the reforms initiated in the

1990s and on the remaining challenges facing the sector. Historically, the authors note, Pakistan's power sector was organized into two state-owned, vertically integrated utilities, KESC (which served Karachi and adjoining areas) and WAPDA (which served the rest of the country). In 2005, 73 percent of KESC was sold to private investors. In addition, the country has 16 independent power producers today. Yet, because of a lack of managerial and financial autonomy, the power sector continues to function largely as a centrally controlled, vertically integrated monopoly. The authors provide a troubling assessment of the state of Pakistan's electricity sector—demand is approaching maximum production capacity, while institutional capacity for policy development and implementation remains low. Failing to resolve these problems may cause investment delays and hamper Pakistan's economic growth.

The Vucetic/Adamantiades essay is one of several contributions in this volume that discuss privatization and argue that Pakistan is unlikely to address its energy challenges successfully without the active participation of the private sector, both domestic and foreign. **Sanjeev Minocha** of the International Finance Corporation, a major source of private sector financing, describes the benefits, from a financing standpoint, of private sector involvement in oil and gas projects. From the perspective of the state, Minocha notes, enlisting the private sector to assume much of the risk associated with oil and gas exploration and development can generate immense revenues with little or no provision of government capital. Private investors are also useful partners in raising the large amounts of capital required for transmission, distribution, and storage infrastructure. In addition, partnership with the private sector brings new technologies and operational efficiencies and helps expand local skills.

Several of the essays presented here feature perspectives from the Pakistani and American business communities. Pakistani businessman **Asad Umar** notes that until the early 1990s, the private sector's participation in the energy sector was limited largely to exploration and production. Over the past decade, however, a number of new companies, including prominent international corporations, have become major players in Pakistan. Privatization of formerly public sector entities has dramatically changed the energy landscape in recent years. Umar emphasizes four roadblocks keeping private enterprise from playing an even larger role in the energy sector: the unstable political situation and attendant law and order problems in Baluchistan; delay in the privatization of public sector energy companies; the political controversy and provincial disagreements associated with storage-based hydroelectric power generation projects; and overlapping responsibilities of the Private Power and Infrastructure Board and the National Electric Power Regulatory Authority. Umar remains optimistic, however, predicting that the role of the private sector will expand in the years ahead, as the government continues its policies of privatization and deregulation.

John R. Hammond of the U.S. Energy Association observes that U.S. investment in Pakistan has traditionally been substantial, but notes a significant drop since 2004. Whereas in 1995 approximately 18 U.S. energy companies were involved in Pakistan, today this number has shrunk to only five or six. This diminished interest in Pakistan is due only partially to developments within Pakistan, Hammond explains; increased U.S. demand has created new opportunities for American companies at home, while a restructuring of the U.S. energy industry has also reduced the industry's appetite for overseas investments. Nonetheless, Hammond also underscores a perception in the U.S. energy industry of heightened political and security risks in developing countries, including Pakistan. Unless foreign investors feel safe in Pakistan, Hammond seems to be saying, they are unlikely to be enthusiastic about doing business there.

Observing that the country will require immense new supplies of electricity by 2030, Hammond argues that Pakistan offers inviting opportunities for foreign investors. But, he adds, significant barriers inhibit U.S. investment in Pakistan's energy sector today, including a lack of knowledge on the part of American businesses about Pakistan's market and regulatory structure; a U.S. preference for sales of goods and services instead of investments; and financing difficulties due to political and financial risks. Pakistan needs to demonstrate to the investing world a "show me element"—successful, unaltered private power investment projects that operate without government interference in contractual agreements. While not minimizing the remaining barriers to increased U.S. investment in Pakistan's energy sector, Hammond, like Umar, credits the Pakistan government with taking meaningful steps to overcome these obstacles, and predicts an improvement in the medium-term investment climate for U.S. (and other foreign) companies.

The U.S. Chamber of Commerce's **Aram Zamgochian** lists seven criteria foreign investors look for before deciding to do business in Pakistan's power sector. Like several of the other authors in this volume, Zamgochian gives the Pakistan government credit for opening its energy and power sectors, and instituting many of the policies necessary to attract foreign investors. Privatization and deregulation in the oil sector are progressing steadily, he asserts. Efforts in building a strong infrastructure, on the other hand, have been lacking, and Pakistan's poor infrastructure results in an estimated 30 percent loss in transmission. Power theft also remains a major problem, he reports. Zamgochian warns that environmental degradation is another issue that potential foreign investors in the energy sector consider when making investment decisions.

The essay by **Bikash Pandey**, director of the South Asia Clean Energy program at the U.S. nonprofit Winrock International, focuses more directly on clean energy and renewable energy options for Pakistan. Pakistan's renewable energy potential—hydro, wind, and solar—is substantial, Pandey asserts, although presently this potential remains largely untapped. Escalating petroleum prices in recent years have given Pakistan an additional incentive to invest in renewable energy technologies. In 2003, the government ambitiously declared that by 2015, 10 percent of the country's total energy supply would come from renewable energy sources, and established the Alternative Energy Development Board to coordinate renewable energy promotion. Modest steps in the direction of greater reliance on renewable energy, such as pilot projects and market-based fiscal incentives, have already been taken.

Nonetheless, renewable energy labors under severe handicaps in competing with conventional energy—hidden subsidies that allow for lower conventional energy generation costs, for example, or policies that permit conventional energy to disregard the costs of the pollution it creates when pricing power. Unless renewable energy is given a level playing field, Pandey warns, a major expansion of renewable energy generation is unlikely, and the government's goal of 10 percent by 2015 will not be met. Pandey draws from his extensive experience in South Asia to provide specific examples of successful clean and renewable energy initiatives in rural areas across India, Bangladesh, Sri Lanka, and Nepal. These technologies, he writes, can be rapidly adopted in Pakistan by replicating the basic business models available in neighboring countries.

The University of Vermont's **Saleem H. Ali** also looks to other developing countries for examples of environmentally friendly energy policies. While Pakistanis often talk about emulating China's development path, Ali writes, they might look instead to Taiwan for lessons on how to promote relatively green growth even in a country with large defense expenditures. Or to take a different example, Morocco has a lower per capita energy consumption rate than Pakistan, yet performs better than Pakistan on human development indexes and industrialization indicators. He also points to Malaysia and Costa Rica as developing countries with environmentally progressive policies from whom Pakistan might learn.

Ali's essay highlights some of the ways in which Pakistani decision makers formulating energy policy should incorporate ecological planning criteria. Instituting appropriate accounting systems for energy demand and supply must be a first step, he writes, followed by national efforts to tackle inefficiencies in energy generation and distribution. Large hydroelectric projects, he cautions, should be viewed only as a last resort after low-cost conservation measures have been fully utilized. The government's current "supply-side approach" to energy has stifled environmental consciousness and efforts toward energy conservation while leading to massive investments in energy generation at the expense of ecological considerations. Above all, Pakistani authorities should reconsider what constitutes a successful energy policy. Ali challenges the perception, for instance, that reaching the country's energy extraction potential is necessarily a sign of achievement. "Definitional mistakes," he warns, have led to major environmental problems in the past.

In brief concluding observations at the Wilson Center conference, Pakistani businessman Zaffar Khan re-emphasized the centrality of secure and affordable sources of energy for Pakistan's future. Job generation, economic growth, and political stability go hand-in-hand with plentiful and affordable energy supplies, he averred. Pakistan, by virtue of its location and natural endowments, has many technologically feasible options to meet its growing energy requirements. The challenge lies in establishing the commercial and political feasibility of these options, and in utilizing the country's limited capital and execution capacity optimally.

Khan's sanguine views appear warranted. Pakistanis are not being asked to find a cure for cancer, or to discover entirely new methods or technologies in order to meet their energy needs down the road. The presentations prompting Khan's optimism, and the essays in this volume, indicate that there already exists widespread agreement on at least the broad outlines of an energy strategy for Pakistan. Pakistanis know what needs to be done.

But solemn promises and soaring rhetoric will not get the job done. Preparing for Pakistan's energy needs over the next quarter century will require long-term vision, a national commitment widely shared among the country's political and business leaders, inspired leadership sustained from one government to the next, and most of all, political will to make and carry out difficult choices. Pakistan—the country, not just the government of the day—needs to decide that muddling through is not enough. Pakistan, as a country, has to decide that it must get serious about creating an energy strategy, and then—and this is the hard part—about implementing it.

Pakistan will not find itself alone in this task. Islamabad's friends around the world believe that it is in their own national interests for Pakistan to succeed—which means, among other things, that Pakistan succeed in its quest for energy security. At the end of the day, Pakistanis themselves must solve the problem of energy insecurity, but the outside world—both the private and the public sectors—can and will help.

Speaking at the Wilson Center conference, the U.S. Department of State's Paul Simons noted that Pakistan's rising energy demand has created new opportunities for regional cooperation in South and Central Asia. Seeking to promote this objective, the U.S. Trade and Development Agency convened a meeting in Istanbul in June 2006 that explored options for exporting Central Asian electricity to Pakistan. Senior officials in the State Department have also spoken enthusiastically about building new energy corridors that would link Pakistan with its Central Asian neighbors. Less happily, not all departments and agencies within the Bush administration have embraced the president's promise to work with Pakistan on energy issues, and the administration as a whole has been slow in following up on the pledges Bush made in Islamabad during his March 2006 visit. President Bush would do well to remind his Cabinet that working with Pakistan on its energy needs is not a question of American largesse, but a matter that is very much in Washington's own interests.

Energy matters for Pakistan. If Pakistan is to flourish…if it is to succeed in its ambitious plans for economic development…if it is to raise the grossly inadequate living standards of its people…if it is to achieve the economic growth necessary to ensure political stability…if it is to create democratic institutions and practices capable of providing good government and reflecting the will of the people…if it is to establish the conditions for long-term financial solvency…if it is to begin to address the many environmental problems that up to now have been largely ignored, and which have a hugely adverse impact on the daily lives of Pakistani citizens…if it is to live in peace with its neighbors, several of whom are directly impacted by Pakistani decision making in the energy sector…if Pakistan is to move toward all these goals, it must successfully address the many challenges it faces in the field of energy.

★ ★ ★ ★

As has been the case with the two previous volumes produced under the auspices of the Wilson Center's Pakistan program, this compilation reflects the hard work and unselfish dedication of numerous friends and colleagues. The authors whose essays appear here deserve commendation for their seriousness of purpose, their patience, and their good-humored and (almost always) prompt responses to the stream of emails that poured forth from our computers. To my coeditors and esteemed Asia Program staff, Bhumika Muchhala and Michael Kugelman, I give special thanks for their professionalism, their attention to detail, and their perseverance. Amy Thernstrom, Aisha U-Kiu, and Grace Kim provided excellent editorial and editing assistance. Without the generosity of the Fellowship Fund for Pakistan and its benefactors, neither this volume nor the Wilson Center's Pakistan program would be possible. And finally, a heartfelt thank you to Munawar Noorani, Zaffar Khan, and Ayesha Haq, who have given that most precious of gifts—their own time.

Notes

1. Government of Pakistan Planning Commission, Approach Paper: *Strategic Directions to Achieve Vision 2030* (Islamabad, February 2006), 11. Emphasis in original.

MEETING PAKISTAN'S ENERGY NEEDS

MUKHTAR AHMED

With a population of 152 million, the economy in Pakistan is currently growing at a rate of over 8 percent, supported mainly by an expanding industrial sector that currently contributes to 38 percent of the economic output and is growing at a rate of 12.5 percent. Per capita energy consumption of the country is estimated at 14 million Btu, which is only a fraction of other industrializing economies in the region such as Thailand and Malaysia. With 40 percent of the households that have yet to receive electricity, and only 18 percent of the households that have access to pipeline gas, the energy sector is expected to play a critical role in economic and social development.

POLICY FRAMEWORK

Key elements of the policy response of the country to meet the energy requirements of an expanding economy are summarized below:

- ***Adequate Energy Supplies:*** The energy sector plans focus on development of indigenous energy resources, import of energy at competitive prices to meet the deficits, infrastructure for delivery of energy to the

---

Mukhtar Ahmed serves as Energy Advisor to the Prime Minister of Pakistan, a position he has held since May 2005. He has 20 years of professional experience in the midstream and downstream oil and gas industry, with private and public sector entities, in the United Kingdom and Pakistan. He has also worked with the Asian Development Bank for 16 years on energy sector operations in Pakistan, Indonesia, China and the Philippines. While on deputation from the ADB, he served as Managing Director/CEO of Sui Southern Gas Company, Ltd (a large integrated natural gas utility in Pakistan). He received his academic training in chemical engineering from the University of Edinburgh.

consuming sectors, and systems to assure reliability, efficiency, and economy of supply.

- ***Security of Energy Supply:*** Recognizing the uncertainty in the international energy markets and emerging requirements of other developing economies such as India and China, the energy plans focus on maximum utilization of indigenous energy resources to lower the dependence on imported energy, and diversification of the energy mix to manage risks and external shocks.

- ***Long-term Viability of the Energy Sector:*** The cornerstone of the government policy to assure long term sustainability of the energy sector is shifting from a predominantly state controlled industry to a structure where the government maintains a strategic presence, while the private sector plays a leading role in development of the energy sector. Supporting policies to achieve this objective include appropriate distribution of responsibilities within the government institutions for policy formulation, regulation, administration to avoid overlaps and conflicts, policies and regulations that provide appropriate incentives and encourage competition in the private sector, and sustainable pricing regimes that account for cost-of-service and subsidies that are transparent and address the social and environmental concerns.

IMPLEMENTATION APPROACH AND STRATEGY

To achieve these objectives, the government has adopted an approach based on implementation of integrated energy development plans that take into account cross-sectoral economic impacts of energy options and projects through the supply and demand chain. Policies and plans in place target further development of indigenous conventional energy resources including oil and gas, hydel (hydroelectric), and coal by providing appropriate incentives and a level playing field to the private sector. Plans for meeting the energy needs of rural areas give special emphasis to exploitation of renewable energy potential, taking into account the economic cost of delivering energy from alternative sources and benefits associated with decentralized resource development. Finally, longer term strategies focus on meeting the energy deficits by establishment of energy trade corridors to capitalize on the proximity of Pakistan to resource rich countries in the Middle East and Central Asia.

PRIMARY ENERGY SUPPLY AND DEMAND

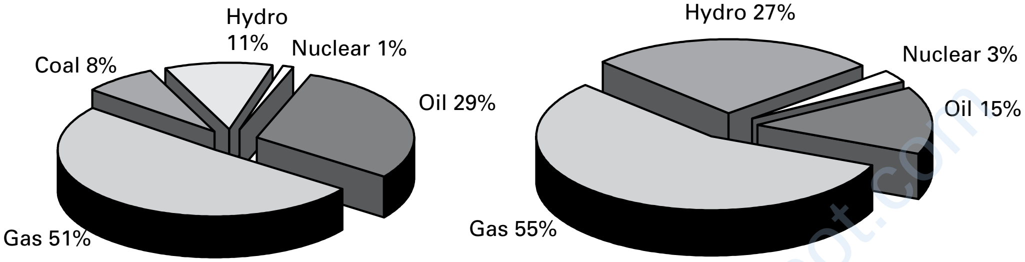
Pakistan has a well developed infrastructure for energy. The gas transmission infrastructure connects to 4.26 million households and commercial establishments in addition to the bulk of the industries and thermal power generating units in the country, and includes 9,060 km of high pressure transmission pipelines and over 225,000 HP of compression capacity. The power transmission and distribution network serves over 16.3 million residential and commercial and 0.23 million industrial customers, and includes 40,500 km of high voltage transmission lines. In addition, a network of oil pipelines transports crude oil and products to inland refineries and market centers, and the ports at Karachi are well equipped to handle import of crude oil and petroleum products that account for a major fraction of the country's demand, and limited quantities of coal imported into the country.

Exhibit 1 summarizes the primary energy supply picture for the country. Total energy supplies were 56 MTOE (million tons oil equivalent) in fiscal year 2005. With an annual production of 3,685 MMscfd (28 MTOE), gas accounts for 51 percent of energy supply, followed by oil at 29 percent, hydel at 11 percent, and coal at 8 percent. Pakistan currently meets only 19.9 percent of its oil demand from indigenous resources.

The power sector accounts for 23 MTOE or 41 percent of energy supply, of which 55 percent is gas, 27 percent hydel, and 15 percent is oil. Nuclear energy accounts for only 3 percent of power generation. Current installed capacity in the country is 19,160 MW of which 34 percent is hydel, and the bulk of the remaining is thermal.

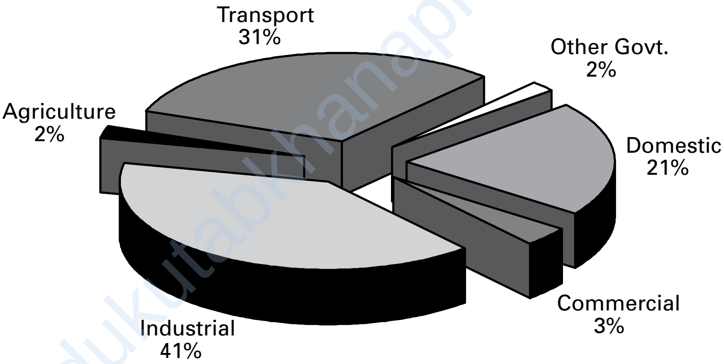
FY 2005 energy consumption by sector is illustrated in **Exhibit 2**. The industrial sector dominates the market with 41 percent of the demand, followed by the transport sector at 31 percent and the residential at 21 percent.

Exhibit 1: Total Primary Energy Supplies: 56 Million TOE and Energy Supply for Power Generation: 23 Million TOE



Source: Pakistan Energy Yearbook 2005

Exhibit 2: Final Energy Consumption: 32 Million TOE



Source: Pakistan Energy Yearbook 2005

PROJECTED ENERGY DEMAND AND DEFICITS

Projected energy demand, assuming a GDP growth rate of 6.5 percent consistent with recent trends, is summarized in **Exhibit 3.** Over the next 20 year period, overall demand for energy is expected to increase by a factor of 3.5, from a current level of 56 MTOE to 198 MTOE.

The projections assume current long term plans for power generation with emphasis on development of coal, hydel and nuclear resources,

Exhibit 3: Projected Energy Demand

	FY05	FY15	FY25	FY05	FY15	FY25
	Million TOE			% Share		
Oil	16	29	47	30	27	24
Gas	28	56	93	48	50	47
Coal	4	9	17	8	8	8
Hydel	7	13	29	12	12	15
Renewable	-	1	5	0	1	2
Nuclear	1	2	7	1	2	4
TOTAL	56	110	198	100	100	100

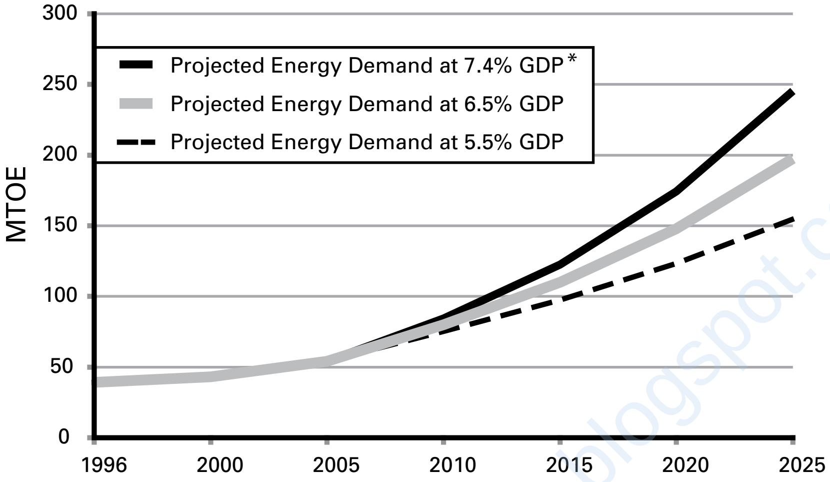
Source: Medium-Term Development Framework: 2005–10, Planning Commission
Note: Government of Pakistan adjusted to GDP growth rate of 6.5% and updated for power generation plans

consistent with the policy of the government to develop the indigenous resource base and diversify the energy mix. The share of oil in the energy mix is expected to drop in view of higher oil prices in the international market, and the policy of the government to switch to lower cost alternatives for power generation, including an aggressive program for development of nuclear power and renewable energy sources.

The sensitivity of demand for energy to the economic growth rate is illustrated in **Exhibit 4**. Alternative scenarios for economic growth assuming growth rates of 5.5 percent and 7.4 percent were considered to test the impact of GDP growth rate on the demand for energy. The 7.4 percent scenario corresponds to an "optimistic" economic growth rate assumed in the Medium-Term Development Framework (MTDF), while the 5.5 percent scenario represents a "reasonably conservative outlook" for economic growth, based on a historic average. Over the next 20 year period, the demand for energy under these scenarios varies by more than 25 percent, dropping to 155 MTOE corresponding to an economic growth rate of 5.5 percent, and increasing to 246 MTOE corresponding to an economic growth rate of 7.4 percent.

Projected indigenous energy supply and deficits corresponding to the 6.5 percent GDP growth rate are summarized in **Exhibit 5**. Production of

Exhibit 4: Energy Demand at Various Economic Growth Rates



**Medium-Term Development Framework: 2005-10. Planning Division assumed a GDP growth rate of 7.4%*

Exhibit 5: Projected Energy Deficits (Million TOE)

	FY05	FY15	FY25
Oil	3	4	2
Gas	26	34	19
Coal	2	5	13
Hydel	7	13	29
Renewable and Nuclear	1	3	12
Total Indigenous Supply	39	61	75
Total Energy Requirement	54	110	198
Deficit	15	50	122
Deficit as % of Energy Requirement	28	45	62

Source: Medium-Term Development Framework: 2005–10, Planning Commission
Note: Government of Pakistan adjusted to GDP growth rate of 6.5% and updated for power generation plans

oil and gas in the country is expected to improve slightly in the near term but decline in the long run, given the current onshore exploration activities and resource outlook, and a low likelihood of a major offshore discovery.

Availability of coal, hydel, nuclear and renewable energy is projected to improve significantly, in line with current resource development plans. The availability of energy from these sources, however, will not be enough to meet the growing demand of the economy. The energy deficit which stands at 15 MTOE or 28 percent of the energy demand presently will increase to 122 MTOE by 2025, corresponding to 62 percent of the demand. This outlook clearly indicates a need to place development of the indigenous resource base on a high priority, followed by long-term arrangements to acquire energy from external sources that are affordable and reliable.

ENERGY RESOURCE POTENTIAL AND RISKS

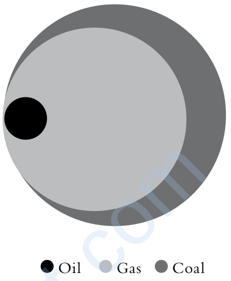
Energy resource potential for the country is summarized in **Exhibit 6.** The reserves to production ratio is currently 13 and 22 for oil and gas respectively, while for coal it is 720, and only 16 percent of the hydel potential has been realized. Major unexploited reserves of coal are located in the Thar Desert in the Sindh province.

Development of these reserves, however, presents a major challenge as the coal is of inferior quality, with a heating value of 5,700 Btu/lb, sulfur content of over 1 percent, ash over 6 percent, and moisture of about 50 percent. The over burden that will have to be removed to access the coal seams is also soft and has a depth in the range of 175-230 m, indicating the need for open pit mining that will involve significant upfront investments. Other constraints that increase the costs and commercial risks in development of Thar coal resources include limited road and power infrastructure to support the initial phases of project development, and scarcity of fresh water in the area.

In case of hydel projects, government plans include an aggressive program to develop sites that have been identified, recognizing the economic benefits associated with power generation as well as storage of water for agricultural use. Constraints and risks that can limit the extent to which this potential can be realized in the near term include location

Exhibit 6: Indigenous Resource Potential

Oil	41 MTOE	309 Million bbl
Gas	629 MTOE	29 tcf @ 900 btu/scf
Coal Proven	991 MTOE	3,303 MT
Coal Inferred	22,680 MTOE	50,700 MT
Coal Hypothetical	50,410 MTOE	112,700 MT
Installed Hydel	6,600 MW	
Potential Hydel	41,700 MW	



Fuel	Annual Production	Reserves to Production Ratio
Oil	24.12 Million bbl	13
Gas	1.34 tcf @ 900 btu/scf	22
Coal	4.59 MT	720
Hydel Potential Realized	16%	

of most of the sites in mountainous regions in the north where construction of access roads can involve significant investments, cost of resettlement of affected populations, and longer lead times associated with detailed technical studies required for project design.

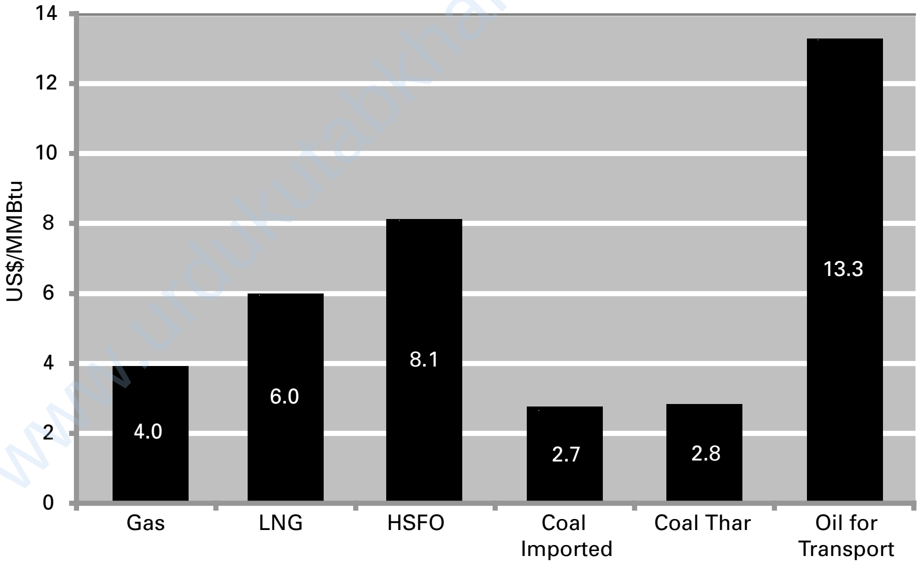
In view of the above outlook for exploitation of the domestic resource base and associated risks, Pakistan has given high priority to tapping the energy resources in the region, and several projects for import of natural gas from the gas-rich countries in the Middle East and Central Asia have received serious attention. These include pipelines for import of gas from Turkmenistan, Iran, and Qatar. In addition, import of power from Tajikistan and Kyrgyzstan, which are rich in hydel resources, is also under active consideration. The development of these options for importing energy has been constrained by the sensitive regional security environment, special technical issues, and complexities associated with commercial and operating arrangements typical of large projects requiring inter-country agreements.

ECONOMIC CONSIDERATIONS IN ENERGY PLANNING

Exhibit 7 illustrates the comparative economic costs of fuels for the country, assuming a crude oil price of $60/bbl and prevailing prices of other fuels in the international market. While delivered cost for local and imported coals is under $3/MMBtu, delivered cost of natural gas and LNG is estimated at $4 and $6/MMBtu respectively, allowing for price differentials associated with liquefaction, transportation, and regasification for LNG and netback values available to the suppliers. The delivered prices of petroleum products are substantially higher than those for coal and natural gas, and are currently estimated at over $8/MMBtu for high sulfur fuel oil (HSFO) and over $13/MMBtu for transport fuels including diesel and motor gasoline.

The economic cost of energy supplied in 2005 **(Exhibit 8)** on the basis of these prices is estimated at $15.3 billion, of which 48 percent is attributable to the oil used in sectors other than power (mainly transport

Exhibit 7: Comparative Cost of Fuels



Note: HSFO price corresponding to US$60/bbl crude. Delivered price of imported coal assumed at US$75/ton and agriculture), 8 percent to HSFO used mainly for power generation, 17 percent to gas used in the industry (inclusive of fertilizer), residential, and commercial sectors, 12 percent to gas used for power generation, and the remaining 15 percent shared by hydel, coal, and nuclear energy. In view of this distribution of energy costs, sectors and end-uses that require special attention in energy planning include oil use in the transport sector, provision of natural gas for sectors other than power where the economics of switching to alternative liquid petroleum and solid fuels such as fuel oil and coal are not favorable, and selection of fuels and technologies for power generation.

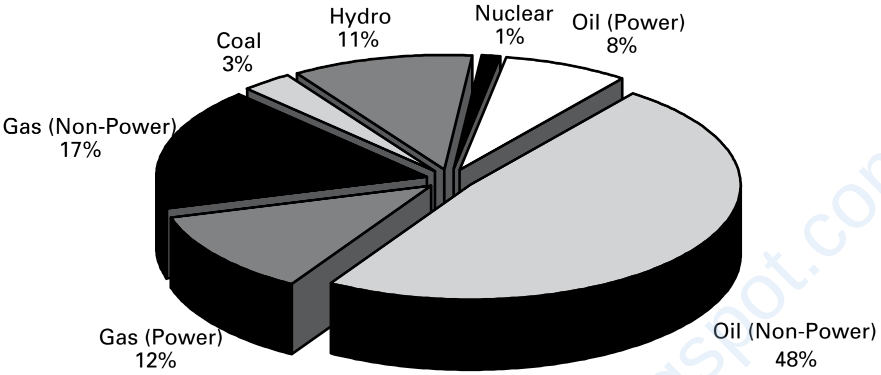
Cost of power generation for alternative technologies and fuels assuming prevailing capital and operating costs and economic cost of energy as indicated in **Exhibit 7** are illustrated in **Exhibit 9**. While the economic cost of electricity produced from coal, natural gas, hydel, and nuclear power plants falls in the range of US cents 5-6/kWh, the cost of producing electricity from LNG approaches 7 cents/kWh, and that from HSFO exceeds 9 cents/kWh. The country therefore cannot afford to install and operate power generation capacity on imported LNG or HSFO. Priorities for meeting the energy needs of the country in the long-term include import of natural gas, generation of electricity from indigenous and imported coal, and development of hydel and nuclear resources.

ENERGY OPTIONS AND SCENARIOS

While the cost of meeting the energy requirements of a rapidly expanding economy will be substantial, the country has a range of options available to manage the supply and demand for energy. The choices made will also determine the extent to which the risks associated with variations in energy prices and availability of fuels in the international market can be managed, and the cost of delays or inability to develop indigenous resources can be absorbed. The following cases were analyzed in terms of total energy requirements, energy deficits and imports, and cost of imported energy:

- Base Case: Unconstrained gas import
- Low Gas: Imported gas not available, LNG and imported coal to replace imported gas in Base Case

Exhibit 8: Cost of Energy, US$15,284 Million



Source: Assumed prices of energy: Oil (power) 8.13 US$/MMBtu, Oil (non-power) 13.30 US$/MMBtu, Gas 4.00 US$/MMBtu
Note: Coal 2.70 US$/MMBtu, Hydro and Nuclear 5.73 cents/kWh (equivalent to electricity generated from imported coal)

Exhibit 9: Cost of Power Generation

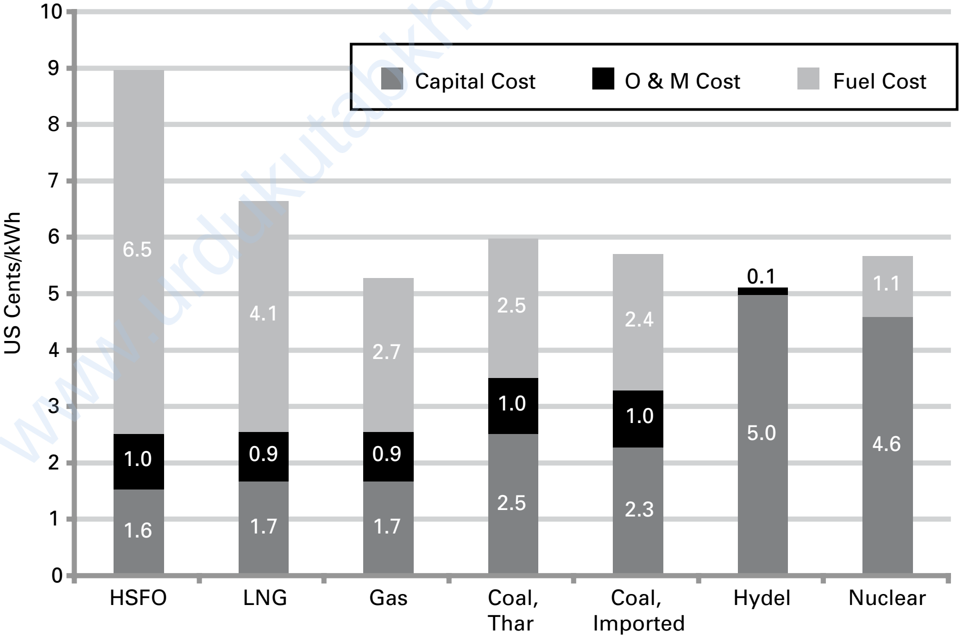


Exhibit 10: Competing Energy Scenarios

SCENARIO	Oil MTOE	Gas MMscfd		LNG MMscfd	Coal MTOE		Hydel MW	Nuclear MW
		Indigenous	Imported		Indigenous	Imported		
Base Case	47	2,290	8,170	750	13	3	20,325	4,400
Low Gas	47	2,290	–	6,060	13	35	20,325	4,400
High Thar	47	2,290	–	6,060	44	3	20,325	4,400
Low Hydel	47	2,290	–	6,060	13	43	14,230	4,400
High Nuclear	47	2,290	–	6,060	13	21	20,325	7,200
Energy Conservation[1]	42	2,060	7,450	675	12	3	18,800	3,740

[1] *Energy Conservation Scenario: Technical potential estimated at 15% for power, 10% for oil and gas in industry and transport sectors. Achievable by 2025 assumed at 50% of technical potential.*

- High Thar: Thar coal to replace imported coal for power generation in Low Gas Case
- Low Hydel: Hydel capacity additions reduced by 30 percent, imported coal to replace hydel power generation in Low Gas
- High Nuclear: Additions in nuclear capacity increased by 100 percent in 2015 and 200 percent in 2025 over the Base Case Energy
- Conservation: Energy conservation applied on Base Case

The Base Case assumes that the country will be able to import natural gas to meet the emerging energy deficits. This is the least costly option, given the proximity of the country to gas surplus regions, the opportunity of transporting gas through inland pipelines, and the economic advantage offered by gas in end-uses such as fertilizer production, combined cycle gas turbines, cogeneration, and CNG (compressed natural gas) vehicles. This case assumes that the gap in power generation capacity, after accounting for the capacity planned on hydel, nuclear, and renewable sources, will be filled by combined cycle gas turbine (CCGT) units operating on imported natural gas.

The Low Gas Case represents the scenario where imported gas is not available, and the deficit has to be made up with the least costly fuel in absence of natural gas. In this case, the country will have to import LNG to meet the established demand for natural gas in the residential, commercial, fertilizer, and industry sectors, and generation capacity in the power sector that can operate only on natural gas. The gap in power generation capacity, filled by imported gas in the Base Case, was assumed to be filled by capacity based on imported coal, which is the lowest cost option in absence of the CCGT option.

The High Thar Case represents the option of enhanced utilization of Thar coal to replace imported coal in the Low Gas Case. The Low Hydel Case represents the case under which the risks associated with development of hydel capacity, such as the negative outcome of feasibility studies or higher than expected resettlement costs, come into play. The hydel capacity additions were reduced by 30 percent for this case, to be replaced by the next economic option, which is imported coal. In the High Nuclear Case, installed nuclear capacity was increased from 4,400 MW in the Base Case to 7,200 MW, assuming a 100 percent increase in capacity additions by 2015, and 200 percent by 2025. Finally, the Energy Conservation scenario assumes a conservative penetration rate for energy efficient technologies and demand side management, resulting in a reduction in demand of about 9 percent across the economy. **Exhibit 10** summarizes the energy demand and the power generation capacity required in each of the above scenarios.

The economic cost of imported fuels under the Base Case is illustrated in **Exhibit 11**. Fuel imports under the base are projected to increase from the current level of $7.5 billion to $38.2 billion in 2025, with oil accounting for 65 percent of the energy imports, followed by gas at 30 percent.

Additional cost of fuel imports under each of the scenarios studied is illustrated in **Exhibit 12**. Annual additional cost of imported fuels for the Low Gas Case is estimated at $0.8 billion in 2015, increasing to $3.2 billion in 2025, and represents the additional cost of energy imports in case the country is unable to import gas through pipelines.

Comparable figures for the Low Hydel Case are $1.2 billion in 2015 and $4.1 billion in 2025, and for the High Nuclear Case are $0.6 billion in 2015

Exhibit 11: Base Case Forecast of Fuel Imports

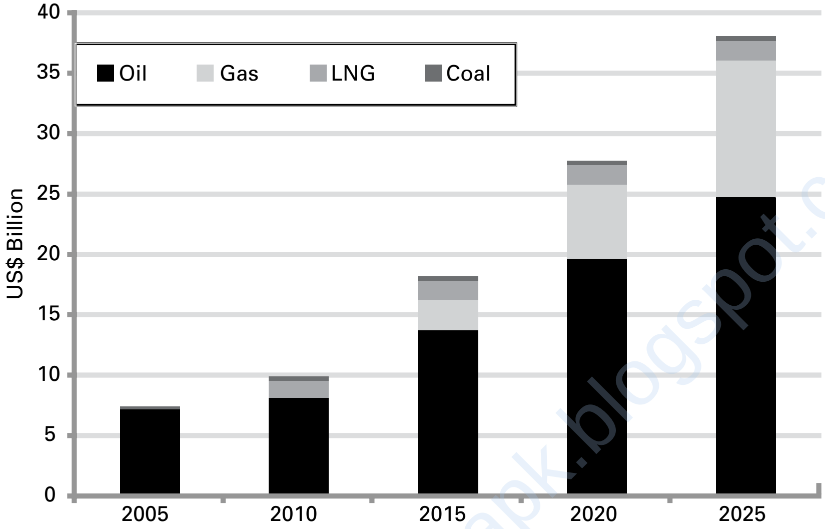
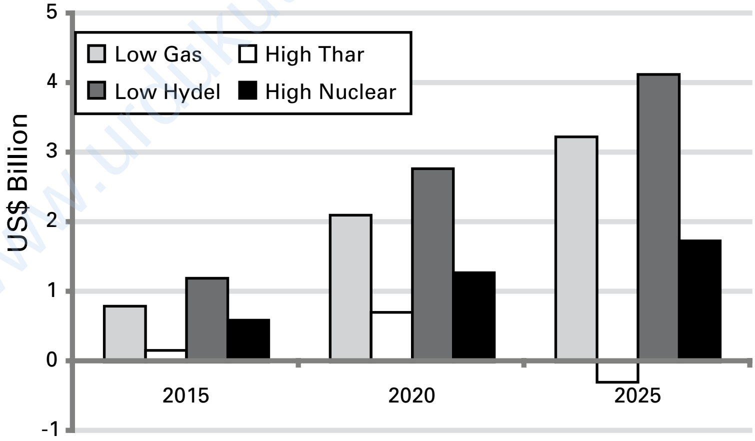


Exhibit 12: Additional Cost of Imported Fuels



and $1.7 billion in 2025. The High Thar Case yields a saving of $0.3 billion in 2025 over the Base Case, on account of lower energy cost of Thar coal.

CONCLUSIONS AND PRIORITY AREAS FOR ACTION

An assessment of the current and projected energy requirements of the country and additional costs for energy imports under alternative scenarios and options leads to the following conclusions:

- While Pakistan has substantial coal and hydel resources, it is not possible to develop and utilize these resources in the short term in view of inherent constraints.
- The dependence of the country on imported energy is therefore expected to increase considerably in the near to medium term.
- Gas import pipelines can deliver energy at competitive prices in the near term to meet the demand of priority consumer segments such as the residential, industrial and power sectors.
- Development of Thar coal and nuclear power in the medium term can secure the country against high energy prices in the global markets and risks associated with large scale development of hydel resources.
- Development of indigenous coal can be coupled with inclusion of imported coal for greater diversity in the mix of imported fuels.

Key elements of an action plan to meet the energy requirements of the country in the long term, to balance the risks associated with rising world energy prices, and to protect the economy against uncertainties in development of domestic resource base include:

Import of Energy

- Implementation of gas pipeline projects, LNG projects and projects for import of electricity from Central Asia on a fast track basis

Development of Indigenous Energy Resources

- Enhanced oil and gas production

- Detailed technical and economic assessment of coal mining and coal based-power generation
- Assessment of advanced technology options for coal gasification and coal bed methane
- Enhanced hydroelectric power generation
- Enhanced nuclear power generation
- Mainstreaming renewable energy

Energy Efficiency and Management

- Optimization of energy mix
- Demand side management in industrial sector
- Mass transit for major urban centers

EMERGING INVESTMENT OPPORTUNITIES IN THE ENERGY SECTOR

The government expects the private sector and foreign direct investment to play a central role in development of the energy sector in the country. Specific investment opportunities in the energy sector where the private sector can participate are summarized below:

Oil and Gas Industry

- LNG Project: Consultants have been engaged to provide advice on technical, financial, and commercial issues, and an RFP (Request for Proposal) will be issued to short-listed firms in the near future.
- Gas Import Pipelines: Technical parameters have been defined through prefeasibility studies and technical working groups, and joint working groups have been established to address technical, commercial, project financing, and other issues.
- Oil Refining: Expressions of interest are being invited for a 200,000 to 300,000 barrels per day coastal refinery located near Karachi.

Electricity and Power Generation

- Import of Electricity from Central Asian states: Further work is being initiated to evaluate the technical and economic aspects of power import.

- Hydroelectric Generation: Proposals have been invited from the private sector for 7 projects with a total capacity of 1,620 MW.
- Power Generation from Thar Coal: Private sector is currently involved in preparation of feasibility studies for mining and power generation.
- Power Generation from Imported Coal: Work has been initiated for involving private sector in setting up power generation units in the coastal areas.
- Power Generation from Renewable Sources: A renewable energy policy framework has been drafted and an incentive package has been defined for fast-track capacity additions.

In addition to the above, the government plans to divest 51 percent of its shareholding in the following concerns to give majority ownership and management control to the private sector:

- Power Generation and Distribution: Jamshoro Power Company, Faisalabad Electric Supply Company, and Peshawar Electric Supply Company.
- Oil Marketing: Pakistan State Oil Co. Ltd., the largest oil marketing company in the country with approximately 70 percent share of the market.
- Gas Transmission and Distribution: SNGPL and SSGCL, state owned utilities that currently account for over 86 percent of the gas transmission and distribution business in the country.
- Petroleum E&P: Pakistan Petroleum Ltd. and Oil & Gas Development Co. Ltd., state owned companies that account for 45 percent of gas and 53 percent of oil production respectively in the country. In the case of Oil & Gas Development Co. Ltd, divestment of 10-15 percent equity through simultaneous GDR offering and domestic secondary offering will precede the divestment of 51 percent shares.

THE WEIGHT OF HISTORY: PAKISTAN'S ENERGY PROBLEM

Shahid Javed Burki

In the summer of 2006, Pakistan was once again faced with a serious energy crisis. The crisis was particularly severe in the electric power sector, where demand now exceeded supply. This was the second time in a decade that this situation had developed. The first time was in the late 1980s to early 1990s, following a rapid growth in the country's economy. Then, as in the 2003-2006 period, the economy was growing rapidly but investment by the public sector in generating electricity had not kept pace with the rapid increase in GDP. This situation has reappeared again with public sector investments in energy falling well short of generating the additional supplies demanded by a rapidly growing economy. It was clear that the government had to increase the supply of energy or the economy would begin to stall. Solving the energy problem has to become the focus of public policy.

Why had the country followed this roller-coaster course? Why had different administrations at different points in the country's history failed to develop strategies that would ensure a sustained supply of energy for the development of the economy? The administration headed by President Musharraf claimed that the economy had the potential to grow at a fast pace, equaling that of the rapidly expanding Asian economies. There were good reasons to be optimistic about the future, but optimism had to be translated into policy that would help to realize it.

Shahid Javed Burki served as Pakistan's finance minister from 1996 to 1997. He held numerous senior positions with the World Bank over a 25-year career, including vice president of Latin America and the Caribbean, and director of China operations. Before his World Bank career, he was chief economist of the government of West Pakistan. Mr. Burki currently writes a weekly column for *Dawn.* He was a Woodrow Wilson Center Public Policy Scholar in 2004, working on a book tentatively titled *Pulling Back from the Abyss: Musharraf's Pakistan Project, 1999-2004.*

Given the belief that the country could do well in the future, why did the Musharraf administration allow power shortages to develop, a situation that was certain to hamper growth as had happened in the past? Why, as had happened in earlier periods, was the government once again resorting essentially to ad hoc measures to deal with the situation? This essay will attempt to provide answers to these questions. The main conclusion to be offered here is that as in several other sectors of the economy, there was a serious failure of public policy. The government once more was failing to address a deep-rooted structural problem in the economy.

This paper has five parts. The first provides an overview of the energy sector before shifting the discussion to the electric power sector. It highlights some of the main differences between Pakistan's energy sector and those in other developing countries at the same stage of development. The second part of the paper focuses on what I have called "the weight of history" to explain the current energy problem. Over the last six decades—in fact since the country gained independence—no serious attempt was made by a succession of governments to supply various forms of energy to different types of consumers. There was a colossal failure of public policy in this respect, which left the country with weak institutions, inappropriate pricing policies and insufficient public sector investment that contributed to what appears to be an inexorable march towards another crisis. The third part analyzes the current demand and supply situation in the power sector, the most important component of the sector of energy. It highlights some of the costs that will be imposed on the economy as a result of the anticipated increase in the demand-supply gap. The fourth part looks at the current administration's strategy for addressing the situation. This strategy is incorporated in the *Medium-term Development Framework, 2005-2015*,[1] which is a weak document in terms of laying down what the government needs to accomplish in order to address the various structural weaknesses the economy faces in the early 2000s. The fifth part will indicate some of the new technologies Pakistan could exploit in dealing with the problem of energy, including the enormous potential of the under-tapped agricultural sector.

THE CURRENT ENERGY SITUATION

Electric power, natural gas, petroleum, coal and wood are the principal sources of energy in Pakistan. The total primary energy supply measured in terms of tons of oil equivalent (TOE) was estimated at 50.8 million in 2003-04 (see Table 1). Demand for energy was increasing at a slightly greater rate than GDP, suggesting an elasticity of consumption of more than one, as is normal for developing countries—this is why energy must remain a high-priority sector for public policy and public sector investment. The structure of consumption has changed over time, especially since 2000-01. The consumption of petroleum products declined at an average rate of 6.5 percent a year while that of gas, electricity and coal increased at the rates of 10.4, 6.0 and 14.6 percent, respectively. The

Table 1: Primary Energy Supply and Per Capita Availability

YEAR	ENERGY SUPPLY		PER CAPITA	
	Million TOE	% Change	Availability (TOE)	% Change
1990-91	28.469		0.253	
1991-92	30.475	7.0	0.264	4.4
1992-93	32.953	8.1	0.278	5.4
1993-94	34.778	5.5	0.286	2.9
1994-95	36.062	3.7	0.290	1.2
1995-96	38.746	7.4	0.304	4.9
1996-97	38.515	(0.6)	0.295	(3.0)
1997-98	40.403	4.9	0.305	3.3
1998-99	41.721	3.3	0.313	2.7
1999-00	43.223	3.6	0.317	1.2
2000-01	44.456	2.9	0.319	0.6
2001-02	45.237	1.8	0.318	(0.4)
2002-03	47.061	4.0	0.321	0.9
2003-04	50.820	8.0	0.340	5.9
2004-05	55.533	9.3	0.371	9.1

Source: Government of Pakistan, chap. 15 in Pakistan Economic Survey, 2004-05 *(Islamabad: Ministry of Finance, 2005), Table 15.8, p. 224.*

consumption of gas increased since the government encouraged its use in power generation as well as fuel for transport. As suggested by these rates of increases in demand, coal has become important, and in 2003-04 accounted for 6.5 percent of total energy supply.[2] Pakistan had begun to focus on the use of coal, as people realized that coal was a major domestic source of energy.

The government was also promoting the use of compressed natural gas (CNG) in vehicles to reduce urban pollution. By March 2005, about 700,000 vehicles were converted to CNG, up from 450,000 in March 2004. This rate of conversion is likely to continue in line with the alarming increase in urban pollution. Some of Pakistan's major urban centers—including Lahore, the country's second largest city and the capital of the booming province of Punjab, the largest province of the country—are counted among the most polluted cities of Asia. But there was hope that the rapid conversion of vehicles to CNG would arrest this trend. According to a government report, "with these developments, Pakistan has become the leading country in Asia and the third largest user of CNG in the world after Argentina and Brazil."[3]

The "weight of history," as discussed in the section that follows, has created a number of distortions in the sector. Of these, at least three are worth noting. First, the share of household consumption is much higher in Pakistan than in other countries at the same stage of development. For electric power, domestic consumption in 2005-06 was estimated at 7,199 MW, 46 percent of total supply (see Table 2). In rapidly developing countries such as those of East Asia in the 1970s and 1980s, the figure was around 20 percent. Industry, with 38 percent consumption of total supply, was the second most important sector, while agriculture, with 11.4 percent, was in third place. Commerce claimed 7.8 percent of the total. The structure of demand was the consequence of the pricing policy and institutional development policies followed for decades. For instance, electric power tariffs encouraged the use of air conditioning in residences. Air conditioning penetrated Pakistan much more deeply than India. On the institutional side, the setting up of two gas distribution companies—the Sui Northern Gas Company and the Sui Southern Gas Company—led to the development of a vast network of gas pipelines that covered most of the country.[4] Within a period of 25 years—1960 to 1985—Pakistan was able to construct one of the largest gas pipeline networks in the developing world.

Table 2: Distribution of Demand for Power, 2005-2010 (Megawatts of electric power)

YEAR	DOMESTIC	COMMERCIAL	AGRICULTURE	INDUSTRIAL	OTHERS	TOTAL
2005-06	7,199	1,216	1,763	5,891	1,035	15,500
2006-07	7,585	1,251	1,820	6,481	1,086	16,600
2007-08	8,127	1,312	1,893	7,252	1,159	17,900
2008-09	8,783	1,354	1,979	8,181	1,243	19,600
2009-10	9,531	1,408	2,079	9,267	1,341	21,500

Source: Government of Pakistan, Medium-term Development Framework, 2005-15 *(Islamabad: Planning Commission, 2006)*

The Musharraf government believes that its policies will lead to a reduction by 2009-10 in the share of total supply consumed by households, to 44.3 percent of projected supply. At the same time, the share of industry will increase significantly—by five percentage points, to 43.1. Islamabad has not clarified how public policy would bring about this change.

The distribution of sources of energy supply is very different in the case of Pakistan compared to other countries in the region (see Table 3), only partly reflecting the existence of domestic resources. In spite of the availability of significant domestic resources of energy such as coal and hydropower, Pakistan has allowed dependence on foreign supplies to increase to the point at which the burden on foreign earnings has become unsustainable. While in 2005 natural gas accounted for slightly more than half of total energy consumption, the shares of hydropower and coal were relatively small. The burden on foreign exchange was exacerbated by the sharp increase in the price of oil in 2006, when spot prices touched $78 a barrel of crude oil during the summer.[5] In 2005, 80 percent of energy demand was met by oil and gas, and oil was mostly imported.

As shown in Table 4 below, the current sources of energy supply in Pakistan were vastly different from those of several other developing countries, including neighboring India. While oil and gas supplied four-fifths of Pakistan's energy requirements, in India coal alone accounted for over half of energy used. Hydroelectricity, at about one-seventh of total demand, had a much higher share in Pakistan than in India.

Table 3: Sources of Energy Supply, 2005-2030 (Million tons of oil equivalent)

Description	2005	2010	2015	2020	2030
Oil	16.80	20.69	32.51	45.47	66.84
Natural Gas	27.10	38.99	52.98	77.85	162.58
Coal	3.30	7.16	14.45	24.77	68.65
Hydro	6.43	11.03	16.40	21.44	38.93
Renewable	-	0.84	1.60	3.00	9.20
Nuclear	0.42	0.69	2.23	4.81	15.11
TOTAL	54.05	79.40	120.17	177.34	361.31

Table 4: Sources of supply in various countries, 2002 (Percentages)

	Pakistan	India	Malaysia	UAE	UK	USA	Canada	China
Oil	30	35	42	32	35	40	30	23.8
Natural Gas	50	7	51	68	35	23	27	2.6
Coal	6.5	55	4	-	16	23	24	67.0
Others (Hydel, Nuclear, etc.)	13.5	3	3	-	14	14	19	6.6

Source: Government of Pakistan, Medium-term Development Framework, 2005-15 *(Islamabad: Planning Commission, 2006)..*

Significantly, more than a quarter of Pakistan's total energy supply came from abroad in the form of fuel oil and crude oil. The former was used for electricity generation, while the latter was processed into gasoline and diesel oil for use in transport. For a country that once again faced a serious overall trade deficit, such a large dependence on imports was neither feasible nor prudent.

DEVELOPMENT OF THE POWER SECTOR: THE WEIGHT OF HISTORY

Electricity is a major source of energy in Pakistan, a significant development since the country's birth in 1947. At the time of independence the country had only two power generating units with installed capacity of 60 MW: one at Malakand in the Northwest Frontier Province (NWFP) located on a tributary of the Indus River, and the other at Shahdara near Lahore that used coal. For several months, the country continued to import electricity from India, but stopped with the first trade war between the two South Asian nations that started in 1949 and lasted for several years. Until that time Pakistan and India's northern states had fully integrated economies.[6] A hydroelectricity plant located at Warsak in NWFP was the first major public sector investment in the power sector in the 1950s. With its inauguration the county briefly achieved a surplus in power and did not depend on supplies of electric power from India. This surplus turned into a deficit as the pace of economic growth picked up in the 1960s when Ayub Khan, the country's first military ruler, took steps to accelerate the rate of gross national product (GNP) growth. GNP growth increased to 6.7 percent a year in the 1960s, the "decade of development" presided over by President-General Ayub Khan.

The sharp upswing in the rate of GNP increase did not immediately place a burden on energy supplies because of some of the investments made by the government of Ayub Khan. Energy generation picked up in the 1970s with the commissioning of a major power plant at Mangla dam on the Jhelum River. The dam was a part of the major "replacement works" undertaken by the government following the signing in 1960 of the Indus Water Treaty with India. The treaty gave three western rivers of the Indus system (the Indus itself and its two northern tributaries, the Jhelum and the Chenab) to Pakistan and three southern rivers (the Ravi, the Beas and the Sutlej) to India. The replacement works involved the construction of two reservoirs—at Tarbela on the Indus and at Mangla on the Jhelum—for storing water while a series of link canals transported water from the Jhelum to the Chenab and from the Chenab to the Ravi. The government of Ayub Khan was able to persuade India and a number of donors, principally the World Bank, to allow Pakistan to use the reservoirs for generating electricity.[7] The government also established the Water and Power Development Authority (WAPDA) to take responsibility for building these massive works for generating power from the large hydroelectricity plants (built along with the replacement works) and for managing the entire irrigation system. For a number of years, WAPDA was a model public sector institution in the developing world for undertaking development works. From 1970 to 1975, installed generating capacity increased from 636 MW to 1331 MW. With the commissioning of the Tarbela dam power plant in the late 1970s, power generation capacity increased to 3000 MW and then more than doubled to 7000 MW by 1990–91.

The investments made in the 1960s to develop the energy sector (in particular to increase electric power generation), along with a slowing down of the economy in the 1970s, carried Pakistan through until the 1990s. In 1994, the government of Prime Minister Benazir Bhutto made a major decision to diversify the ownership of the power generating capacity by inviting independent power producers (IPPs) to invest in the country and offering generous incentives to attract foreign capital. The government allowed IPPs to charge tariffs from WAPDA that were well above WAPDA's usual cost for power generated by its own sources. This created a heavy financial burden for WAPDA and a fiscal liability for the government since WAPDA's losses were met from the budget. Even the World Bank, which helped Pakistan formulate the policy that led to the IPPs, failed to anticipate the long-term burden this policy was likely to impose.[8]

The other long-term problem with the policy was that it preferred imported fuel oil over domestic natural gas as feed stock for the private generating plants. The assumption was that natural gas was too precious a resource for power generation and should instead be used as an input for the production of fertilizers, insecticides and other chemicals, and for household consumption for which the country had built a vast network of pipelines. Policymakers in Islamabad assumed at the time that the price of imported oil would remain within easy limits, and the favorable terms on which oil imports were available from Saudi Arabia would be maintained. These assumptions proved wrong and very costly for the economy.

Nonetheless, the policy supporting the IPPs worked in the short term to attract investment into the power sector. When Prime Minister Bhutto's government was dismissed by President Farooq Ahmad Khan

Table 5: Total Installed Generation Capacity (MTOEs)

Source of power	Installed capacity 2003-04	% Share	Installed capacity 2004-05	% Share	% Change
WAPDA	—	58.2	—	58.3	0.9
- Hydel	6460	57.7*	6463	57.2*	0
- Thermal	4741	42.3*	4835	42.8*	2.0
IPPs	5835	30.3	5873	30.3	0.7
Nuclear	462	2.4	462	2.4	0
KESC**	1756	9.1	1756	9.0	0
TOTAL	19254	100.0	19389	100.0	0.7

**Share in WAPDA System*
***Karachi Electric Supply Company.*
Source: Hydrocarbon Development Institute of Pakistan; Government of Pakistan, Medium-term Development Framework, 2005-15 *(Islamabad: Planning Commission, 2006).*

Leghari on charges that included corruption—including corruption allegedly associated with the grant of permits to independent power producers—two dozen IPPs had received Islamabad's permission to build power plants in the country.[9] As a result of this policy, the IPPs installed almost 6000 MW of generating capacity, and accounted for more than 30 percent of the capacity in the power sector in 2004-05 (see Table 5).

In Pakistan, an energy crisis occurred after every period of rapid growth. For example, there was pressure on the power supply in the mid-1970s following a decade-long economic expansion under Ayub Khan (1958-1969). As already discussed, this period saw massive investment as part of the Indus Water replacement works. However, the full impact of that investment was not felt until the completion of the massive Tarbela dam in the early 1970s, after electricity shortages had begun to be felt. The shortage did not cost the economy, since the economic growth rate had declined significantly under President/Prime Minister Zulfikar Ali Bhutto, Ayub Khan's civilian successor. Bhutto's massive restructuring of the economy slowed down the rate of increase in GNP to 4.4 percent per year from 1970 to 1977—2.3 percentage points lower than in the 1960s.[10]

It was during the 1990s that Pakistan experienced the first major mismatch between economic growth and increase in power. Between 1977 and 1988—the third time the military was in control[11]—GDP increased by 6.5 percent per year and GDP per capita by 3.5 percent. But the energy supply failed to keep pace with the increase in demand caused by growth. The predictable happened, and the economy slowed down. Constraint on energy supply was one of the many reasons for sluggish performance of the economy during the 1988–1999 period. However, as already discussed, the rich incentives provided to IPPs by Benazir Bhutto's government brought in external finance. Within five years the country moved from a serious power deficit to power surplus. By then, Benazir Bhutto was out of power and Nawaz Sharif was prime minister. His government, convinced that the previous one had indulged in corrupt practices, harassed the IPPs and brought an end to the flow of foreign direct investment into the energy sector.

Nawaz Sharif's government also carried out long and protracted negotiations to draw up a new contract with the Hub River Power Company, a consortium of foreign investors put together by the World Bank. This group had developed the largest generating unit in the country in the private sector, which produced 1200 MW of power and was of critical importance to Karachi, Pakistan's largest city and the center of the country's finance and commerce. But the Sharif government seemed unconcerned about the damage the dispute might do to either Karachi's economy or Pakistan's ability to attract foreign capital for the power sector. This episode had a serious impact on how the foreign community of investors looked upon Pakistan as a possible destination for green field investments, particularly in the energy sector.

Before the controversy over the Hub River erupted, the project was considered a model of what could be achieved in combating energy-supply shortages in the developing world by multilateral development agencies such as the World Bank, working in partnership with the private sectors in both developed and developing countries. After the prolonged dispute over the Hub River, the project began to be cited as an example of the difficulties encountered in doing business in the emerging economies. The effect on Pakistan was particularly severe. The country did not receive foreign investment in energy for almost a decade. There was no new direct foreign investment in the energy sector from 1997 to 2006.

Table 6: Electricity Shortages in the WAPDA System

Year	Peak demand MW(1)	Maximum demand MW(2)	Forgone demand [(2) as percentage of (1)]
1986	3,933	1,746	44.4
1989	5,440	2,151	39.5
1992	6,532	1,048	16.0
1996	8,166	2,492	30.5

Source: Pervez Hasan, Pakistan's Economy at the Crossroads: Past Policies and Present Imperatives *(Karachi: Oxford University Press, 1998), Table 6.8, p. 297.*

When the military returned to power in October 1999, this time under General Pervez Musharraf, it showed a willingness to work with the private sector and settle a number of old disputes. An agreement was reached with the owners of the Hub River project, and power from the large fuel-oil plant in Karachi's vicinity began to flow into WAPDA's extensive power grid. Agreements with other IPPs were also reached. At the same time, the rate of economic growth began to slow down significantly as Pakistan adopted the stabilization program developed by the International Monetary Fund (IMF). As Pakistan achieved a healthy balance of payments situation, constraints on the growth in aggregate demand, and hence on the increase in GDP imposed at the urging of the IMF, were removed in 2002. IMF resources were no longer needed to build up foreign exchange reserves; official capital had begun to arrive in large amounts as the attention of the donor community once again returned to Pakistan after the terrorist attacks of September 11, 2001. During this period of economic stabilization, the IMF forced constraints on the public sector, and the share of the public sector development program (PSDP) declined to a historical low of 2 percent of GDP—it had reached almost 11 percent under Zulfikar Ali Bhutto (1971-77).[12] Energy, and electric power in particular, was one sector that suffered.

As shown in Table 6, a fairly precarious situation had developed by the late 1990s in the power system operated by WAPDA. Forgone demand had increased to 30.5 percent, calculated as a percentage of maximum demand to peak demand. The situation was partly resolved by additional capacity that came on line as a result of the investment made by independent power producers.

Pakistan's economy picked up in 2003 and since then has grown at an average annual rate of 7 percent per year, touching 8.4 percent in 2004–05. But, as happened before, the supply of energy did not keep pace with the sharp increase in demand. Consequently, the country was once again faced with a serious energy shortage.

HEADING ONCE AGAIN TOWARD CRISIS

For the second time in a decade and a half, energy demand began to outstrip supply by the summer of 2006. Demand exceeded supply not by a wide margin but by an amount significantly large to bring back the black-outs and brown-outs that had been common in the 1980s and early 1990s. Meanwhile, the system experienced an unmanageable strain, resulting in both involuntary and voluntary load shedding. In the above-cited *Medium-term Development Framework,* the government provided an estimate of the supply-demand gap, and the deterioration that looked likely during 2005-2030. In the five years between 2005 and 2010, the gap was expected to grow to 3.21 million TOE, or 4.2 percent of total supply. By 2020, the gap was estimated to widen to 39.5 percent of likely supply, increasing to almost 64 percent by 2030 (see Table 7). These were, of course, theoretical numbers since consumption cannot exceed supply. In reality, consumption has to equal the amount of power that gets generated. When theoretical demand exceeded supply by amounts as large as those projected by the government, balance was achieved by forcing cuts in consumption, either by forced reduction in energy use or through the price mechanism. Either case involved a heavy cost on two counts—for the economy in terms of forgone growth, and for the society in terms of loss of comfort and serious reduction in economic opportunities.

How heavy was the economic cost? This question, surprisingly, has not received the kind of attention it deserves from Islamabad. Informed debate on how to deal with expected energy-supply shortages, including the pros and cons of various policies, can only occur when the economic cost of under-investment in the energy sector is carefully analyzed, along with impacts on employment levels, poverty, and the distribution

Table 7: Demand and Supply Projections, 2005-2030 (Million tons of oil equivalent)

	2005	2010	2015	2020	2025	2030
Supply	54.04	76.19	98.66	127.11	168.16	220.37
Demand	54.05	79.40	120.17	177.34	255.37	361.31
Gap	0.0	(3.21)	(21.51)	(50.23)	(87.21)	(140.94)
Gas Import-1	-	5.0	15.6	15.6	15.6	15.6
Gas Import-2	-	-	5.0	27.0	27.0	27.0
Gas Import-3	-	-	-	5.0	27.0	27.0
Gas Import-4	-	-	-	-	15.0	27.0

Source: Government of Pakistan, Medium-term Development Framework, 2005-15 *(Islamabad: Planning Commission, 2006).*

of inter-personal and inter-regional incomes. As noted below, the question of the construction of the dam at Kalabagh on the Indus River was intensely debated in 2005-06, but much of the discussion was based on old arguments.

Below are some rough estimates of the effect of the developing demand-supply gap in the energy sector. Without a serious effort to increase supply, energy availability is expected to increase at the rate of 5.75 percent per year from 2005 to 2020. This assumes fairly large investments by the public sector and some limited participation by the private sector. However, this rate of increase in power generation will reduce the rate of growth in GDP by 1.25 percent per year in this 15-year period. Compounded, that would mean a total loss of 20 percent in the national product. Putting the same calculations another way, Pakistan's GDP per capita with adequate supply of energy could double in the next 15 years, increasing from the present $700 to $1400 in constant terms by 2020. However, without an effort to increase supply, GDP per capita would possibly increase to only $1,175. The loss of average income would be around $225 per head in 2015, significantly affecting the incidence of poverty, distribution of interpersonal income, and distribution of regional incomes. Other possible costs—such as slower progress towards a truly representative political system, a rise of Islamic extremism, and further detachment of the economy from the global system—would also have to be included in assessing the full cost of neglecting the energy sector.

In the case of the energy sector, public policy failed to use price policy to constrain waste and encourage distribution of supply to those sectors that would use energy most productively and efficiently. It failed, further, to establish public sector institutions that could use available resources efficiently, develop a long-term strategy for insuring a steady increase in energy supply, and make the sector attractive for private investors, domestic and foreign. Particularly critical, as the international price of oil and gas increased significantly in early 2006, was the government's failure to use price to regulate demand and to distribute consumption to those areas and sectors of the economy that had most need for energy. The government also did not further develop the institutional base as the demand and supply of energy became more complex.

As discussed above, the government of Ayub Khan had taken a significant positive step in institutional development by setting up WAPDA. The government also encouraged the construction of an extensive system of gas pipelines by setting up two pipelines in the public sector for fuel distribution. However, the country needed to focus on creating the regulatory capacity to determine the tariff structure, and to guide the relationship between generating units (increasingly in private hands) and transmission and distribution (remaining with the pubic sector). Pakistan set up the National Electric Power Regulatory Authority (NEPRA) in the mid-1990s to determine the structure of tariffs, but did not grant it full autonomy from the heavy hand of politics. Also, deterioration in the quality of governance in the 1990s affected WAPDA, which was considered a model in the developing world. Corruption eroded WAPDA's capacity to deliver services effectively to consumers. The Musharraf regime did not develop a cohesive and forward-looking approach, and energy development remained ad hoc and subject to the whims and wishes of those in senior positions. Much of the public sector's analysis of the energy problem was confined to making simple supply and demand projections for the next quarter century.

Tables 8 and 9 below provide the government's estimates for the next quarter century of demand and supply from various sources. While Table 5 presented data in million tons of oil equivalent, these two tables use methods of measurement that are common to different energy sources.

In terms of domestic supply, coal is envisaged to change most sharply—an increase of almost 40-fold, from about four million tons in 2004-05 to 153 million tons 25 years later. The smallest increase is projected in oil, while the supply of coal is set to increase four-fold in the 2005-2010 period and almost 12-fold between 2010 and 2030.

However, comparing the two tables in terms of demand and supply projections suggests that while there is a balance in the case of coal,

Table 8: Demand Projections

Source description	2004-05	2009-10	2019-20	2029-30
Oil (petroleum products) (Million tons)	16.8	20.69	45.47	66.84
Gas (Millions of cubic feet per day)	3173.0	4565	9114.0	19035
Coal (Million tons per annum)	7.4	16	55.36	153

Table 9: Domestic Supply Projections

Source description	2004-05	2009-10	2019-20	2029-30
Oil (petroleum products) (Million tons)	12	12	18	18
Gas (Millions of cubic feet per day)	4033	4424	3001	2299
Coal (Million tons per annum)	3.9	13.0	55.36	153

there are serious supply shortfalls in the case of oil and gas. In the case of oil, the gap between projected demand and (domestic) supply enlarges from less than five million tons in 2004-05 to almost 50 million tons in 2029-30. The change in terms of gas is even more dramatic: in 2004-05, production exceeded demand, but projections show the demand-supply gap surging until consumption outpaces supply by more than eight times by 2030. The feasibility of this scenario depends on three critical assumptions: first, that Pakistan will be able to increase its export earnings at a rate to permit such a sharp rise in imported oil; second, that the planned natural gas pipelines connecting Pakistan with the rich gas fields of Iran and Turkmenistan—and perhaps Qatar—will get constructed; and third, that the country will gain access to clean-coal technologies that are being developed in the United States and would be used for tapping the large deposits available in the deserts of Sindh province.

MUSHARRAF GOVERNMENT'S STRATEGY FOR SOLVING THE ENERGY CRISIS

Musharraf's administration has become increasingly concerned about the rapidly widening energy supply-demand gap. As discussed above, the government anticipated that the gap would widen at the rate of 25 percent a year, from 0.6 million tons of oil equivalent (MTOEs) in 2006 to 141 MTOEs in 2030—an untenable situation, as already discussed.

The awareness of the problem, however, did not result in a well thought-out strategy. *The Medium-term Development Framework*, which was presented as a comprehensive strategy for placing the country on a sustainable path of development, was no more than a long wish-list of projects and intentions. According to the *Framework,* the government hopes to increase energy supply by 7.5 percent a year, slightly more than the 7 percent increase projected in GDP, bringing the elasticity of energy demand to more than one. This would be done by using mostly indigenous sources of energy, including rivers, natural gas and coal. Incentives would be provided to the private sector to generate power; energy prices would be rationalized, keeping subsidized tariffs intact for poor domestic consumers; major utilities would implement a program for reducing energy losses; renewable sources for energy would be developed; and the transmission system would be modernized.

According to government plans, it would "bring electricity to every village in the country by 2007 under the Kushal Pakistan Program and the villages not on the grid would be provided electricity through alternative sources of energy." The announcement was made by Prime Minister Shaukat Aziz, who also put some pressure on the government of the NWFP to facilitate the construction of a small hydroelectricity generating station on one of the several tributaries of the Indus. The government also attempted to draw investment into some of the nontraditional areas. In September 2006, Islamabad announced that it had granted permission to build a windmill farm to generate 50 MW of power. These were all ad hoc measures; they did not represent any deep reflection on resolving a problem that has affected the performance of the economy for several decades.

What is required is a strategy that brings together various strands of initiatives aimed at increasing supply and managing demand. On the side of supply, the Musharraf government will need to gather the political will to exploit the enormous hydroelectric potential available to the country. As shown in Table 10, Pakistan has one of the world's largest river systems. For instance, the Indus River is longer than the Columbia, with a catchment area almost twice as large, but generates only half the amount of energy. The bulk of the 6,460 MW of electricity produced by the Indus system comes from two dams—the Mangla on the Jhelum and the Tarbela on the Indus. The plans to construct another large dam on the Indus at Kalabagh, downstream of Tarbela, have been on the planning books for three decades. The dam was not constructed because of the severe opposition from the provinces of the Northwest Frontier that feared that the lake at Kalabagh would drown the historic city of Nowshera. The opposition from Sindh was based on the possibility that the storage at Kalabagh would reduce water flows to its farms. There was also the fear that the reduction in the amount of water flowing into the Arabian Sea would produce destructive tidal waves.

At one point in the winter of 2005–06, Musharraf seemed set to announce the construction of the Kalabagh dam. However, following an intense national debate conducted mostly in the editorial and opinion pages of most newspapers, the president decided to put the project on

Table 10: Water Use in the World's Major River Systems

River Basin	Catchment Area (1000 sq km)	Length (Km)	Average Annual Flow (MAF)	No. of dams	Storage Capacity (MAF)	Percentage Storage	Power (MW)
Colorado	141	2,320	12	4	60	500	4,167
Nile	3,349	6,650	75	1	132	175	2,000
India (Total)	-	-	750	4,436	245	33	-
Yellow	745,920	5,464	345	7	68.95	20	1,160
Columbia	668	1,950	179	3	34	19	12,602
Indus	1,166	2,880	145	3	13.64	9	6,460
Darling	-	-	2	-	4,705	-	-
World	-	-	20,000	-	8,000	40	-

Source: Government of Pakistan, Medium-term Development Framework, 2005-15 *(Islamabad: Planning Commission, 2006)*

hold.[13] He announced instead that his government would construct half a dozen large dams on the Indus River system, including the one at Kalabagh, but did not suggest a timetable to be followed. This decision was widely seen as a concession to those who had opposed the construction of the dam at Kalabagh.

The Musharraf government also did not make a serious move on the demand side by allowing the development of a tariff structure that would rationalize the consumption of energy. As discussed above, there were serious differences in the pattern of consumption of energy with some of the resources being used in sectors that did not contribute much to economic development or to poverty alleviation. The distorted structure of tariffs was the main reason why there was high level of consumption in these sectors. And the government made only a small gesture towards using some of the renewable sources for producing energy that were becoming popular not just in the developed countries but also in the developing world.

UNCONVENTIONAL MEANS FOR SOLVING AN OLD PROBLEM

While this is not the place to discuss at length Pakistan's agricultural sector and its potential, it will suffice for our purpose to underscore one important point about this part of the economy. Agriculture is performing well below what it could contribute to the economy. Pakistan has the largest contiguous irrigated area in the world—a system well developed over more than a hundred years. The soil is good, carried for hundreds of thousands of years by rivers that flow from high mountains in the east and northeast to the western sea. The farming population is hardworking and reasonably receptive to change. Agriculture has the potential to contribute to the solution of the developing energy problem.

Sugar is one of the main crops grown in Pakistan. Some argue that it makes little economic sense to grow sugar when the country is facing a water shortage. However, this could change if the country adopts and develops a technology for turning sugar into fuel for vehicles. A considerable amount of work is being done—in the United States and Brazil, in particular—to turn sugarcane into fuel for vehicles. "Think of each stalk of sugarcane as containing three sources of energy," wrote the well-read columnist Thomas Friedman in a recent article for the *New York Times*. He then went on to praise the technology being developed in Brazil:

> First, the juice extracted from the cane is already giving us ethanol and sugar. Second, the bagasse is already heating very low-technology, low-pressure boilers, giving us electricity. But if Brazil's refiners converted to new high-pressure boilers, you could get three times as much electricity. Finally, when the cane is harvested the tops and leaves are often just left in the field. But this biomass is rich in cellulose, the carbohydrate that makes up the walls of plant cells. If the sugar locked away in cellulose also could be unlocked—cheaply and easily by a chemical process—this biomass could also produce tons of sugar ethanol. There is now a race on to find that process. A breakthrough is expected within five years, and when that happens it will be possible to extract 'more than double' the amount of ethanol from each sugar stalk.[14]

Given what has already happened to the price of oil—and what might happen as the supply-demand gap tightens further—this type of technological development can no longer be treated as exotic. It has to become a reality, particularly in Brazil, which (like Pakistan) has an agricultural sector with high potential. Not only is this Latin American country spending enormous amounts of resources on research to improve the economics of sugar as a source of fuel, it is also distributing the fuel in novel ways. Ethanol, produced from sugar, is being used extensively in cars that are equipped to use it as well as gasoline. The choice, however, has been left to the consumers through the use of the price mechanism. Sugar ethanol sells at the pump for little over US$2.00 per gallon while a gallon of gasoline costs a little more than $4.00. Because sugar ethanol gets only about 70 percent of the mileage of gasoline, drivers have to calculate whether switching to sugar ethanol makes economic sense. In the meantime, the government expects that market forces will push up the price of gasoline, while technological developments will reduce the price of sugar ethanol.

However, for an agriculturally rich country such as Pakistan, policymakers must also take note of one other technological development: the use of cellulose instead of sugar from sugarcane for producing fuel. The sources of cellulose are grasses that are commonly available in areas such as the *katcha* lands on the banks of rivers. Scientists working with this source of energy are confident that once they have developed the needed technologies, grass could become a much cheaper source of ethanol than sugarcane.

Work is also proceeding on another technological breakthrough. Seed and technology companies see opportunity in developing corn and other crops genetically engineered to produce ethanol and other biofuels. Syngenta, a U.S. company, hopes to begin selling in 2008 a genetically engineered corn designed to help convert itself into ethanol. According to one report, "each kernel of this self processing corn contains an enzyme that must otherwise be added separately at the ethanol factory."[15] However, corn is not the only crop being worked on. DuPont and Bunge, two other U.S. companies, have formed a joint venture to improve soybeans for providing bio-diesel fuels. Ceres, a plant genetics company in California, is working on turning switch grass into an energy crop.

This science would, in a sense, achieve the opposite of Pakistan's green revolution of the 1960s. Then the country adopted the high-yielding rice and wheat varieties that were developed in Mexico and the Philippines, respectively. One objective of the green revolution's technology was to increase a substance called lingnin in the stalks of plants. Since the high-yielding plants were heavy with grains, they needed strong stalks to support them. However, lingnin interferes with the conversion of the plant's cellulose into ethanol, and its content in the stalk has to be reduced.

These then are some of the technologies that need to be adapted and used in order to turn agriculture into a resource for energy. Therefore, creating public-sector technology institutions for undertaking research such as the above should be part of the strategy to tackle the energy problem.

CONCLUSION

The main thrust of this paper is to underscore the need for a comprehensive strategy to deal with the problem of energy. Crucial components would include appropriate price policy, the development of various institutional devices, investment in new technologies, and cooperation with neighboring countries. There are many lessons to be drawn from Pakistan's economic history that should inform the development of such a strategy, which would finally enable Pakistan to get off the roller-coaster of the past 60 years in dealing with its energy sector.

NOTES

1. Government of Pakistan, *Medium-term Development Framework, 2005-15* (Islamabad: Planning Commission, 2006).

2. Government of Pakistan, chap. 15 in *Pakistan Economic Survey, 2004-05* (Islamabad: Ministry of Finance, 2005) 187-203.

3. *Pakistan Economic Survey, 2004-05,* 95.

4. The discovery and exploitation of a vast deposit of natural gas at Sui in the south of Balochistan made a significant contribution to the development of Pakistan. Sui fields were located in the area dominated by the Bugti tribe, whose *sardar* (chief), Nawab Akbar Khan Bugti, was of the view that his tribe was not adequately compensated by the federal government. This resentment contributed

to several periods of Baloch insurgency, most recently in 2005-2006. In August 2006, Sardar Bugti was killed by government troops while hiding in a cave near the Dera Bugti, his place of residence.

5. The price dropped significantly in September-October 2006, but there was a consensus among experts that this was a temporary easing of the situation brought about by a build-up in inventories in the United States.

6. For a discussion of the circumstances that led to the war and its consequences for the economic development of Pakistan, see Shahid Javed Burki and Mohammad Akbar, "Pakistan" in *South Asian Free Trade Area: Opportunities and Challenges* (Washington: USAID, 2005). The study was conducted by a team, led by the present author, of economists who were recruited from five South Asian countries.

7. See Aloys Michel, *The Indus, A Study of the Effects of Partition* (New Haven: Yale University Press, 1967) for a detailed story of the replacement works.

8. The first time the World Bank took serious cognizance of the contingent fiscal liabilities involved in IPP-type programs was with reference to the Bank's work in Latin America. See Shahid Javed Burki, Sebastian Edwards and Sri-Ram Aiyer, eds., *Annual World Bank Conference on Development in Latin America and the Caribbean* (Washington: World Bank, 1995) 15-40.

9. In December 1996, pending a new round of elections, I—as finance minister in the interim government that took office after the Bhutto dismissal—cancelled all permits issued by the previous government that had not resulted in any physical investments. Of the two dozen permits that were granted by the Bhutto government, 13 IPPs were allowed to proceed with the construction of power plants.

10. I have told this story in some detail in Shahid Javed Burki, *Pakistan Under Bhutto, 1971-77* (London: Macmillan, 1980).

11. The first period of military rule lasted for 11 years, 1958–1969, when General (later Field Marshal) Mohammad Ayub Khan was in power. The second period lasted for only 23 months when General Agha Mohammad Yahya Khan was the country's chief executive. The third period, under General Zia ul-Haq, lasted for a little more than 11 years, 1977–1988. The fourth period began with the military takeover on October 12, 1999. General Pervez Musharraf was first appointed chief executive before becoming president in the summer of 2001.

12. See Pervez Hasan, *Pakistan's Economy at the Crossroads: Past Policies and Present Imperatives* (Karachi: Oxford University Press, 1998) Table 4.11, p. 216.

13. I contributed to this debate with a series of op-ed articles in *Dawn* in November and December of 2005.

14. Thomas L. Friedman, "The Energy Harvest," *New York Times*, September 15, 2006, A23.

15. Andree Pollack, "Redesigning crops to harvest fuel," *New York Times*, September 8, 2006, C1.

ENERGY, POVERTY REDUCTION AND EQUITABLE DEVELOPMENT IN PAKISTAN

SABIRA QURESHI

Pakistan is grappling with many daunting challenges as it struggles to balance efforts towards sustaining high economic growth rates on the one hand, and meeting its poverty reduction targets on the other. The rapid success on the economic growth front in recent years, second fastest in Asia last year, is still very fragile. When coupled with a dismal picture on its human development indicators, and deepening social inequalities, Pakistan presents an interesting dichotomy.

In the energy sector, Pakistan, along with a large number of developing countries, is facing two crucial, and related, problems. The first is the widespread inefficient production and use of traditional energy sources, which pose economic, environmental, and health threats. The second is the highly uneven distribution and use of modern energy sources, which pose important issues of economics, equity, and quality of life. In Pakistan, as elsewhere in the developing world, the priorities of energy policies are disproportionately oriented towards the elite rather than the poor. What then are some of the approaches that the government can take to improve access to energy for rural and poor people and facilitate an affordable transition to modern and more sustainable uses of energy?

Sabira Qureshi has 25 years of experience in the international development field with a focus on gender equality, poverty alleviation, and human rights. Her work on gender mainstreaming includes the non-traditional infrastructure sectors, particularly energy and environment. She is a consultant with international multilateral and bilateral agencies and government and civil society organizations, with a regional focus on Pakistan and South Asia. She has worked on women's human rights issues, and served on the first National Commission on the Status of Women in Pakistan. In addition, she operates a chain of community-based schools in very low-income urban slum communities in Islamabad under an education trust she founded and currently manages.

This essay analyses the links between energy policies and poverty reduction efforts in Pakistan, and discusses how energy policy and programs can be better leveraged to address these challenges.

ANALYTICAL FRAMEWORK: LINKAGES BETWEEN ENERGY, EQUITABLE GROWTH AND POVERTY REDUCTION

The energy sector can help address the challenges of poverty through two means. First, the energy sector can support the provision of services to meet basic needs, such as education, health, clean water and sanitation, as well as to improve livelihood opportunities. Second, economic growth and development can be enhanced through improved productivity at the

Analytical Framework of Energy-Poverty Linkages

Policies and Programs Supporting:	Formal Sector Modern Energy Sources Urban/Commercial Use	Informal Sector Traditional Energy Sources Rural/ Domestic Use
Basic Needs and Improved Livelihoods	Some attention in recent years to improve access; sustainable pricing remains an issue: • accelerated village electrification program; • piloting off-grid gas distribution networks; • alternative energy projects; Need more effective subsidy targeting to make modern fuels affordable for the poor	No official recognition of traditional fuels as a significant energy resource despite dominant role of biomass in HH energy consumption; Lack of policies/programs to introduce modern biomass technologies and efficient fuel utilization practices
Economic Growth	Dominant focus of current government energy sector policies and planning, particularly for commercial use	No recognition or focus at all on the potential contribution of traditional energy sources to economic growth

individual and macro-economic level. This is illustrated in the chart on the following page.

Human development can be gauged in terms of the choices and opportunities available to individuals. Energy can dramatically widen these choices. The global community firmly recognizes the centrality of energy services for achieving all the Millenium Development Goals (MDGs), as stated in the ninth session of the Commission for Sustainable Development (CSD-9), held in 2001: *To implement the goal accepted by the international community to halve the proportion of people living on less than US$ 1 per day by 2015, access to affordable energy services is a prerequisite."* The World Summit on Sustainable Development (WSSD) reaffirmed the critical importance of energy services—in particular, increased access to reliable, affordable energy services, as the fundamental facilitator of poverty reduction.

Income measurement alone does not fully capture the absence of choice that poverty represents. The energy consumption patterns of poor people, especially their reliance on traditional fuels in rural areas, tend to keep them impoverished. There is ample literature highlighting the myriad linkages between energy and poverty. It is well established that "energy poverty," or the lack of access to modern energy, inhibits the ability of the rural poor to escape from poverty, while its availability opens a range of transformation opportunities. Energy availability also contributes to lowering birth rates, potentially slowing urban migration and reducing pressure on rapidly growing cities, along with its close links to a range of social issues, particularly the lack of opportunities for women. Studies also confirm the highly beneficial impacts of electricity on the poor, including their lifestyles, living conditions, income and livelihoods. However, an integrated approach is necessary, including the need for complementary infrastructure, to resolve broader problems of poverty and gender inequality, beyond energy service provision per se.

PAKISTAN'S SOCIO-ECONOMIC CONTEXT

Macro-Economic Situation

Pakistan has turned around a deteriorating macroeconomic situation to a rapidly improving one in the last several years. Gross domestic product

(GDP) grew by an estimated 5.1 percent in 2002-03 while inflation remained low at 3.3 percent. The GDP grew to 6.4 percent and 8.4 percent in 2004 and 2005 respectively, with inflation rising to 9.3 percent in 2005. The budget deficit was contained at 4.6 percent of GDP, though the trade deficit was high at 10 percent of GDP, primarily due to rising volumes, as well as prices, of oil imports. However, the improved economic outlook remains fragile until the government is able to sustain sound economic policies in the medium to long term, accompanied by increased investments.

Human Development and Poverty Ratios

A key factor in Pakistan's slow progress towards poverty reduction has been its low investment in its human resources. The recent economic growth has not yet translated into a commensurate decline in poverty or a significant improvement in Pakistan's human development condition. The 2005 United Nations Human Development Index (HDI) ranks Pakistan 135 out of 177 countries, up from 142 in 2004. While there has been some improvement in the indicators for health, nutrition, population, and education, these still remain among the lowest in the world, and also lag behind most South Asian countries. While environmental data are limited and of variable quality, there is also evidence of widespread environmental degradation in Pakistan.

On the UN Human Poverty Index (HPI-1), Pakistan still ranks 68 among 103 developing countries. The measurement of poverty and government claims of reducing poverty have fueled much debate in Pakistan recently. Lack of accurate data to substantiate these claims exacerbates the problem. Whatever the discrepancies, approximately one in four Pakistanis lives below the poverty line, and many more are at a high risk of falling into this category. The picture is also one of unchanging inequality in Pakistan over the last few decades.

Pakistan's Progress in Meeting the Millennium Development Goals (MDGs)

Pakistan is doing well on some of the MDGs indicators and lagging on others. Adult literacy, immunization, and disease control have seen rapid progress, while it is off-track on income poverty, hunger, under-five mortality and primary education. Pakistan's MDGs Progress Report highlights its problems in meeting these goals. Despite recent increases in budgetary allocations to the social sectors, these still remain among the lowest in the region, reflecting government priorities vis-à-vis the "harder economic development sectors."

DISPARITIES

Within the above-mentioned indicators lie large-scale disparities. Sizeable differences in income per capita across Pakistan have persisted or widened over time, with corresponding social disparities. This essay focuses on three of these inequalities, each entrenched in deep-rooted fundamental causes.

Urban-Rural Divide

The poverty head count in 1986-87 was 29.8 percent urban and 28.2 percent rural. In 2003 these figures transformed to 22.4 percent urban and 38.7 percent rural, signaling a dramatic deterioration in the rural condition. A similar trend of a widening urban-rural gap is found in other social indicators. Pakistan's majority rural population remains in the grip of a feudal and tribal system which continues to neglect its human development needs. Spurts of rapid industrial growth from the 1960s onwards led to the economic development of a few major urban centers, but had no significant impact on the vast majority of the rural population. The ruling political elite, with close links to the feudal class, did not encourage agricultural reforms or large-scale investments in rural development. This was exacerbated by periodic crop failures and drought in the rural regions, and lack of access to adequate basic social services by the rural poor. Severe energy poverty in the rural areas worsened the situation.

Inter-Regional Divide

The incidence of poverty varies significantly between regions, from a low of 16 percent in northern Punjab to 44 percent in the Northwest Frontier Province (NWFP). This is accompanied by widening disparities in the human development sectors, within and between regions.

The energy sector throws up additional regional disparities, particularly in the case of Balochistan. Richest in natural resources, yet poor in economic terms, Balochistan is Pakistan's largest province by land, but sparsely populated. With its vast reserves of natural gas, petroleum and minerals, Balochistan has immense potential, yet 45 percent of the population lives below the poverty line. Little of the wealth produced in Balochistan has found its way back into the province, which remains underdeveloped and confronts a major financial crisis even as new natural gas discoveries continue. Ironically, the bulk of the province, except for a few cities, remains without access to natural gas, even as this energy source spreads across the country. In addition, despite the fact that its natural gas generates $1.4 billion annually in revenue, the government remits only $116 million in royalties back to the province. Not surprisingly, therefore, there is rising resentment in the province, and the Balochistan region has seen a succession of revolts against political centralization and resource exploitation. The mountainous parts of NWFP and Pakistan's Northern Areas also remain energy starved due to historic under-investment in generation and distribution.

The primary factors responsible for the unequal pace of development between and within the provinces include the pattern of federal government investments, mechanisms for intergovernmental resource allocation, and an unequal starting point at independence. Political pressures, representing the interests of the dominant groups and majority provinces, rather than objective needs, have largely driven the planning and resource allocation process in Pakistan.

Taxation in Pakistan is highly centralized, with the federal government collecting over 85 percent of the tax revenues. A certain share of the tax revenues attributable to hydro, gas and so on are directly paid to the provinces as their share. The rest goes to the federal divisible pool, a part of which is transferred back to the provinces on the basis of population. For example, Balochistan, with almost half of Pakistan's land mass and a high rate of poverty, receives only 5 percent of the divisible pool resources reflecting its population share. While this matter is currently under active review, so far the different stakeholders have been unable to reach consensus on how best to revise this resource-sharing formula. The issue remains hotly contested as the smaller provinces demand the inclusion of criteria other than population in order to compensate for revenue generating efforts and historically embedded inequalities. Water distribution has also suffered from this lack of political consensus, which is stalling the development of major new hydropower development schemes.

Gender Divide

The overall status of women in Pakistan, including their legal, political, social and economic status, remains one of the most challenging across the globe in terms of persistent gender disparities. While Pakistan's Gender Empowerment Measure (GEM) has improved (from second lowest) to a ranking of 71 out of 80 countries, and its Gender Development Index (GDI) to 107 out of 140 countries, Pakistan's dismal gender equality statistics still present a challenge. Seventy percent of those living below the poverty line are women. Female illiteracy is 68 percent and maternal mortality, at 530 per 100,000, remains among the highest in the world. Additional statistics for women's employment and labor force participation provide an equally daunting picture. Violence against women continues unabated and discriminatory laws remain on the statute books, further compounding women's status

Given the key role women play in household energy use, the stark gender divides are reinforced by a lack of access to modern fuels. Energy poverty further marginalizes rural women and girls who spend a disproportionate amount of their time collecting fuel-wood and water, severely hampering their opportunities for livelihood and economically productive activities. Women and girls are further burdened by the adverse health impacts caused by indoor pollution, linked to the use of traditional fuels for cooking.

THE ENERGY SECTOR IN PAKISTAN

Pakistan's total energy consumption of about 58 million tons of oil equivalent per year is growing at 10 percent annually. This translates into per capita energy consumption of 0.37 kilogram tons of oil equivalent per year (ktoe). The primary sources for energy consumption, in descending order, are biofuels, natural gas, petroleum products, coal and hydro.

Availability of official data on the use of traditional fuels is very limited. This paper draws on the 1994 Energy Sector Management Assistance Project (ESMAP) entitled "Pakistan Household Energy Strategy Study" (HESS), which is still one of the most comprehensive sources of information on biomass consumption patterns in Pakistan. The household sector, the fastest-growing energy consuming sector in the country, accounted for 54 percent of the total final energy consumption in Pakistan in 1994. Biofuels accounted for 86 percent of total household consumption, of which firewood accounted for 54 percent (and 31 percent of total final energy demand), dung 18 percent, and crop residues 14 percent. Ninety percent of the rural and 50 percent of the urban population depended on biomass fuels. Among the modern fuels, natural gas accounted for 7 percent, electricity 4 percent, and kerosene and liquid petroleum gas (LPG) 3 percent respectively for household consumption.

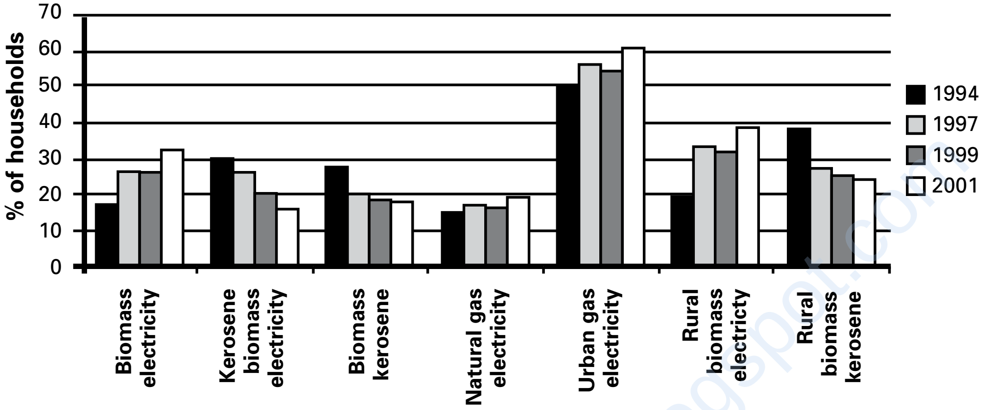
Biofuels were principally used in traditional stoves to meet the bulk of household cooking, space heating and water heating needs. Natural gas was used mainly for cooking and heating in urban areas, and accounted for about 50 percent of the total modern fuel consumption in the residential sector. Electricity was used mainly for lighting and space cooling, and accounted for a further 31 percent of total fuel consumption. Kerosene was also used for cooking, and for lighting where electricity and gas were not available. More recent (2003) data indicates that the residential sector still accounts for 50 percent of total energy consumption, of which biomass provides 78 percent.[1]

Trends Over the Past Decade

Findings from the 2006 ESMAP study highlight the impact of changing availability of different energy sources and their price levels on household energy choice, energy consumption as well as energy expenditure. The uptake of electricity, natural gas and LPG increased in both absolute and percentage terms, signifying that expansion in access surpassed population increase. Prices of electricity, natural gas, kerosene and LPG rose faster than the consumer price index, as a result of which kerosene usage fell dramatically, and LPG less so. There was an uptake of free biomass in both urban and rural areas, the largest increase occurring among the bottom 40 percent in urban areas. Fuel-wood consumption also increased. Electricity constituted the highest household expenditure, followed by natural gas. The most significant finding was the change in energy mix from kerosene-biomass-electricity in 1994 to biomass-electricity in later years, as more people were able to switch to electricity due to expanding supply.

Electricity is the fastest growing source of energy in Pakistan. At present there are approximately 15.6 million consumers, growing at a rate of

Household Energy Choice Combinations



Source: Masami Kojima, "Pakistan Household Use of Commercial Energy," World Bank/Energy Sector Management Assistance Project, 2006.

5.7 percent annually. In 2001, approximately 75 percent of households were connected, varying from 60 percent for the lowest income decile to 90 percent for the highest. However, the increase in total electricity consumption by the domestic sector, in the last decade, rose only by 2.6 percent. The government's ambitious village electrification program, growing at an accelerated pace of 11.6 percent per annum in recent years, aims to provide complete coverage of rural areas by 2007. The following figures illustrate these findings:

The table below shows the global correlation between low income levels, GDP in purchasing power parity (PPP) per capita, low per capita energy consumption, and a high reliance on traditional fuels, particularly in the residential sector. This underlines the importance for government energy policies in developing countries to address the modern use of traditional fuels.

Common Barriers to Accessing Modern Energy Sources

Globally, and particularly relevant to Pakistan, the most common barriers to accessing modern energy services, especially electricity and gas, are the lack of access to a network and affordability concerns. In Pakistan, electricity networks have still to reach many rural areas while

Global Correlations of Economic Indicators and Energy Consumption

Country	Population	GDP (in PPP USD millions)	GDP (PPP USD per capita)	Total Energy Consumption ((ktoe)	Energy Consumption per capita	% residential	% of total from Biomass	% of residential from biomass
Brazil	188,078,227	1,492,000	7,933	161,907	0.86	13%	27%	41%
China	1,313,973,713	7,262,000	5,527	885,437	0.67	36%	25%	69%
Philippines	89,468,677	430,600	4,813	26,522	0.30	23%	31%	56%
Egypt	78,887,007	316,300	4,010	36,695	0.47	20%	4%	9%
Sri Lanka	20,222,240	80,580	3,985	7,397	0.37	45%	54%	90%
Indonesia	245,452,739	827,400	3,371	115,922	0.47	46%	36%	74%
India	1,095,351,995	3,319,000	3,030	394,168	0.36	57%	53%	83%
Pakistan	165,803,560	347,300	2,095	57,581	0.35	50%	44%	78%
Bangladesh	147,365,352	275,700	1,871	17,754	0.12	58%	45%	78%
Nepal	28,287,147	39,530	1,397	8,690	0.31	90%	87%	95%
Nigeria	131,859,731	125,700	953	88,943	0.67	78%	85%	97%

Source: International Energy Agency, "Energy Balances of Non-OECD Countries, 2002-2003 – 2005 Edition," 2005, available from http://www.iea.org/w/bookshop/b.aspx?Subject=Non-OECD%20Countries.

gas distribution networks are concentrated in cities. This is compounded by high connection costs to grid supplied services, corroborated by the HESS study, which indicated that 60 percent of unconnected urban households living within 50 meters of a gas main line were prevented from using natural gas due to the high connection cost.

The literature also reveals that the poor are often able and willing to pay for energy services when they can invest this increased productive capacity in income-generating activities. This important fact underscores the need to integrate the latter as part of a broader development strategy.

ENERGY POLICIES AND STRATEGIES IN PAKISTAN

There is no single comprehensive energy policy or strategy in Pakistan. Several sub-sector policies and strategies have been announced by the government intermittently. However, inter- and intra-sectoral linkages remain weak. A striking feature common in all government energy policies and official economic reports is the lack of recognition of the major role of traditional fuels, which continue to supply about half of Pakistan's total energy consumption.

A review of the various energy sub-sector policies and strategies reflects the same omission, where the emphasis is on large scale, commercial supply and demand factors, focusing on economic growth. Energy policy planners continue to concentrate on meeting the country's rapidly growing energy needs in the formal sector, while failing to respond to poverty reduction needs, particularly as they relate to rural household consumption. Pakistan's Energy Security Plan of 2005 to 2030 forecasts a seven-fold increase in total primary energy consumption and a greater than eight-fold increase in the requirement of power over the next twenty-five years. Private sector investment, including privatization is high on the government's agenda. However, this will impact energy consumption patterns at the household level, as responsibilities for energy provision increasingly shift to a profit-driven private sector. The resultant rising prices will further exclude the poor based on their ability to pay.

In contrast to its energy policies, Pakistan's environmental policy and conservation strategies are more sensitive to the livelihoods of the rural poor, and also draw essential inter-sectoral linkages. The forestry policy also draws important linkages with wood-fuel use for household consumption in rural areas. The enormous environmental challenges facing Pakistan, however, require more effective implementation mechanisms in place.

To reiterate, a major gap in all the above policies and strategies is the glaring lack of attention to traditional fuels, which continue to dominate energy consumption in the residential sector, and for a large part of the rural economy. Unfortunately, few of the sound recommendations provided by the HESS study regarding traditional fuels have found their way into state policy.

The dominant role of the public sector in energy provision in Pakistan, and the very large investments involved, make concerns regarding lack of accountability, transparency and good governance in the sector particularly relevant. The reform process has achieved very little progress in these areas to date. This can dilute poverty reduction efforts, with an adverse impact on access and affordability.

SUB-SECTOR POLICIES

Power

Power is the fastest growing energy sub-sector and poses the greatest challenge. A new policy aims to ensure cheap electricity generation to meet the rapidly growing demands of the economy, coupled with tariff controls to provide wider access to a growing population. The village electrification policy aims to extend electricity coverage to all rural areas over the next few years. Appropriate pricing that can ensure financial viability of the utility, through restructured distribution companies, while also providing an affordable basic level of service, including connection fees, for the lowest income groups, remains a challenge. Revenue neutral options, such as rolling connection fees into monthly payments, are worth considering. Tunisia provides useful lessons in balancing conflicting priorities of state subsidies, integrating rural electrification with rural development goals, and maintaining the commercial viability of a public electricity company, as it approaches universal electricity coverage.

There is increasing recognition of the need for a comprehensive hydropower policy to meet looming power shortages in the future. Pakistan confronts multiple dilemmas as it struggles to balance its growing energy needs with the adverse social and political impacts of large hydro projects. Compensation policies need to be updated to better protect the interests of the poorest groups, including those without formal title to land. Some of those affected by the Tarbela dam, constructed decades ago, still await full compensation for loss of land and assets. Smaller, off-grid hydro schemes are being planned to serve the energy needs of scattered local populations in Pakistan's mountainous regions.

Natural Gas

Dependence of the formal economy on natural gas in densely populated urban areas is high and growing through the manufacturing and transportation sector as well as urban residential use. Projections point to the need for importing significant quantities of gas in the future to support continued growth and diversification of energy sources. Very recently, the government has piloted some investments in off-grid distribution networks to provide gas to under-served areas such as Gwadar. Subsidized tariffs for residential consumers, primarily upper and middle-income groups, make the large-scale replication of such pilots commercially unviable. In spite of being the fuel of choice, the lack of distribution networks and connection fee barriers makes natural gas inaccessible and unaffordable for most poor households. The impending privatization of the two large gas utilities is unlikely to support continuation of commercially unviable initiatives, unless there is an explicit government subsidy.

Petroleum

The government of Pakistan is restructuring and privatizing its large public sector entities, in addition to strengthening regulatory mechanisms. Petroleum tariffs are already deregulated and are regularly adjusted to reflect international prices. Skyrocketing global oil prices affect everyone, albeit unequally, having a particularly regressive impact on the poor, who tend to spend a much larger share of their disposable income on energy and are forced to switch back to traditional fuels in response to such hikes, with concurrent welfare losses.

Renewable Energy

The present contribution of renewable energy sources is negligible in the total energy picture of Pakistan. In line with its diversification strategy, the government has established the Alternative Energy Development Board (AEDB), and is currently developing the first alternative energy policy. The government has an ambitious target of achieving a 10 percent share for renewable energy in the total energy mix in the country by 2010. Its primary focus is on wind and solar technologies to provide energy to remote off-grid areas, but is also promoting waste-to-energy projects in large urban centers. These initiatives are unlikely to have a significant impact on poverty in the short to medium term.

There is no explicit policy on the modernization of traditional fuels, which remain limited to the household level, with no role or involvement of the government. Successful initiatives by many countries in the use of modern biomass technologies provide useful lessons. These include China, the Philippines (with its large scale, grid- based biomass electricity generation, dedicated biomass energy plantations, decentralized and co-operative ownership, national co-ordination, and integration of social and environmental benefits within the program design), India, Thailand, Indonesia, and Myanmar. Nepal has a National Framework for Biogas Policy, and a human resource training plan for its implementation. Ironically, the lack of government control in this sector in Pakistan and elsewhere in the developing world has helped the poor, by not restricting their access to these fuels (particularly wood) where available. However, these supplies are now increasingly scarce.[2]

Coal

The government's increased interest in developing Pakistan's large reserves of coal have led to the preparation of a comprehensive Coal Policy, currently underway, focusing on coal production, and establishment of coal-based power generation plants, for manufacturing and processing industries. Use of coal at the domestic level is negligible and future government policy in this area is still unclear, and will require careful management of social and environmental impacts.

Poverty Reduction Policies and Resource Allocation Trends

Numerous macro-economic policy frameworks have been developed over the last decade, which include the Poverty Reduction Strategy Paper (PRSP) 2003, the Medium Term Development Framework (MTDF)

2005-10, and the more recent Vision 2030 Approach Paper. These recognize the urgent need to tackle poverty, but limit interventions to traditional employment generation and basic social service provision solutions. The links to energy poverty and explicit measures to deal with this are overlooked. They also do not adequately address the critical nexus of gender, poverty and energy. Looking ahead to the next 25 years, the MTDF remains focused on the commercial use of energy in the formal sector, failing to recognize the predominant reliance on biomass by the rural population and urban poor, and their energy needs.

Pricing and Subsidies

A review of the energy poverty nexus is incomplete without discussing pricing and subsidies. While remaining popular among policy makers and the public, studies increasingly show that subsidies do not actually reach the target group, and instead benefit the middle-class and well-to-do. There has been a shift in global approaches to subsidies over the last decade. The 1990's saw the tendency to advocate full-cost-recovery to improve the financial viability of the utilities. However, this proved difficult, in practice and politically. There is now a growing recognition that subsidies are an important component of utility service pricing, at least over the medium term, but need to be applied without undermining overall financial viability.

Which type of subsidy best meets the needs of the poor? The poorest generally remain unconnected to the utility network, and therefore do not receive the subsidy benefits. Where lower-income households are connected, consumption differentials between poor and non-poor allow the latter to capture a larger absolute value of the subsidy. Thus, quantity-targeted subsidies have been found to be invariably regressive. "Connection subsidies" are increasingly being viewed as a promising option, especially when combined with complementary non-price approaches to making utility services accessible and affordable to poor households.

The 1994 HESS study indicated that the overall share of household expenditure spent on fuels decreased as income levels rose, although total household fuel expenditure increased in absolute terms. Low income rural households spent an equivalent of about 21 percent of total household expenditure on fuels, whereas low income urban households spent about 13 percent. The lack of access to a connection was the main reason why households remain without gas. Lower-income groups, who remain unconnected, are forced to use fuels such as dung, firewood, and kerosene, which are unsubsidized and the prices of which, therefore, reflect market realities. These prices are considerably higher than the prices of natural gas for residential uses, constituting a negative subsidy or tax on lower income groups. While current connection fees are subsidized, poor urban households still find it difficult to pay them, forcing them to resort to secondary connections, as the only viable means of obtaining access.[3] Thus, they end up paying more than if they were officially connected, because of increasing block tariffs.

Because of the formal marketing and distribution systems for kerosene, LPG, natural gas and electricity, the government can use taxes and subsidies on these fuels as policy instruments to influence fuel consumption. While kerosene and LPG prices are generally in line with their economic value, the average price of electricity and natural gas to residential consumers remains significantly below their long run marginal cost/economic value. This leads to wasteful expenditure and greatly limits the financial viability of expanding network coverage to currently un-served areas.

There is a need to review the current pricing and subsidy policy, which is often inappropriately targeted, non-transparent, open-ended, and generally unsustainable. It is currently not an effective way of supporting the lowest income groups. The government recognizes this and is considering the development of an "Energy Subsidy Policy" in Pakistan to address this anomaly. Political commitment may require a "transition strategy," involving viability gap financing assistance, output-based contracts backed by financial support, and protective measures for lower income end-users. It may also involve the alignment of investment programs to the end-user's ability to pay.

THE WAY FORWARD

Should Pakistan transition more rapidly towards modern fuels? Should more attention be paid towards improved modern technologies for biomass usage? Is there an ideal mix? What are the short, medium and long-term options for Pakistan in these areas, particularly in the context of its poverty reduction goals and MDG targets? Existing government policies do not fully address these questions, the answers to which are rendered more difficult by the total neglect of traditional fuels in official data sources.

The household fuel of choice—natural gas—will not be available to most rural households for some time, given supply and infrastructure constraints. Improved natural gas pricing is one policy area that merits government attention. Given the seeming willingness of households to pay a premium for its convenience and cleanliness, phasing out cross-subsidies for residential users of natural gas seems politically feasible. LPG remains a viable alternative for rural households willing and able to pay for it. However, high international prices will inhibit the transition to LPG.

Traditional fuels are going to continue to play a dominant role in meeting household energy needs for some time, as much progress still remains to be made before modern commercial fuels become widely used for cooking and heating across rural Pakistan. Fuel efficient cooking stoves are, and will continue to be, an important intervention, which therefore, needs to be expanded and up-scaled in a gender-sensitive and cost-effective manner. However, government policies clearly need to move beyond this narrow focus on efficient cooking stoves in villages to conserve fuel wood, and instead actively promote the shift from traditional to modern biomass technologies to meet the rapidly growing needs of its rural and low-income urban population. Pilot initiatives on setting up biogas plants have already begun, and need to be assessed for their feasibility and replicability. Micro-hydro is another low-cost supply option with potentially large scale application in Pakistan that needs to be more aggressively pursued.

The forestry policy in Pakistan needs to be more closely linked to the energy policy, together with improved management of forest resources, which, despite being meager, contribute a good deal to the economy, and to the livelihood needs of the rural poor. Governance issues within the forestry department need critical attention, particularly in controlling the timber mafia—a major factor behind the rapid deforestation in Pakistan.

CONCLUSION

The near invisibility of the role of traditional fuels in the government of Pakistan's policies and plans renders achievement of poverty reduction targets very difficult, especially in view of the fact that the energy mix in the household and rural sector remains dominated by traditional fuels. This will only change over time, through a gradual transition to modern fuel use, as household incomes rise. In the meantime, it is imperative that government policies and strategies explicitly recognize this, and focus efforts on introducing modern biomass technologies and efficient fuel utilization practices, through locally based solutions, to help meet its short to medium-term poverty reduction targets. Furthermore, there needs to be explicit recognition of the need to mainstream gender in all energy initiatives.

Second, the transition to modern fuels can be greatly facilitated through the adoption of enlightened pricing and subsidy policies, to ensure that continuing expansions in energy infrastructure remain commercially viable but also affordable. Third, careful geographical targeting of future energy investments and network expansion plans will be needed to rectify historical neglect and help ensure social sustainability and political cohesion.

Fourth, for human development and poverty reduction in all its dimensions, it is imperative to address governance issues responsible for social exclusion of the poor, women, and minorities. The voices of the poor need to be heard and taken into account in prioritizing investment decisions that affect their future. Partnerships with the not-for-profit sector and civil society organizations can facilitate this. Finally, it is important to combine mutually reinforcing strategies to reduce both income and energy poverty, and explicitly focus policies and strategies on poverty and distributional impact to meet the MDG targets and short and longer term needs of the lower income and marginalized groups, particularly women. This will also support overall economic development. Efforts towards this end, however, will require better inter-sectoral policy coordination, and integrated development approaches. The costs of inaction are high.

NOTES

1. International Energy Agency (IEA), "Energy Balances of Non-OECD Countries, 2002-2003. 2005 Edition," 2005, http://www.iea.org/w/bookshop/b.aspx?Subject=Non-OECD%20Countries.

2. Government interference in the marketing and distribution of traditional sources of energy can be counterproductive and non-sustainable—e.g., Gujarat, India.

3. Indirect access through a primary user.

REFERENCES

Aissa, Ahmed Ounalli Moncef, et. al. 2004. "Low-cost Electricity and Multi-Sector Development in Rural Tunisia: Important Lessons from the Tunisian Success Story." World Bank Energy Sector Management Assistance Program/ Energy and Mining Sector Board. Available from http://siteresources.worldbank.org/INTENERGY/Resources/Electricity_and_Multisector_Development_Tunisia.pdf.

Barton, Thomas, et. al. 1997. "Our People, Our Resources—supporting rural communities in participatory action research on population dynamics and the local environment." United Nations Population Fund and The World Conservation Union. Available from http://www.iucn.org/themes/spg/Files/opor/opor_pub.html.

Food and Agriculture Organization. 1993. "Wood Energy Development: Planning, Policies and Strategies – Volume III," Papers presented at the Seminar on Policy Instruments for Implementation of Wood Energy Development Programs. Available from http://www.fao.org/DOCREP/006/AD542E/AD542E00.HTM#vol3.

Foster, Vivien, et. al. 2006. "The Distributional Incidence of Residential Water and Electricity Subsidies." World Bank Policy Research Working Paper No. 3878. Available from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=936032.

Heijndermans, Enno, and K.V. Ramani. 2003. "Energy, Poverty and Gender – A Synthesis." World Bank. Available from http://www.worldbank.org/astae/enpogen/.

International Energy Agency. 2005. "Energy Balances of Non-OECD Countries, 2002-2003 – 2005 Edition." Available from http://www.iea.org/w/bookshop/b.aspx?Subject=Non-OECD%20Countries.

Jellinek, Serjio, et. al. 2006. "Who Benefits from Water Utility Subsidies?" World Bank. Available from http://wbln0018.worldbank.org/water/bnwp.nsf/files/WhoBenefitsfromWaterUtilitySubsidiesSUM.pdf/$FILE/WhoBenefitsfromWa terUtilitySubsidiesSUM.pdf.

Kartha, Sivan, and Gerald Leach. 2001. "Using Modern Bioenergy to Reduce Rural Poverty." Stockholm Environment Institute. Available from http://www.recambodia.org/Downloadable/Downloadable%20Documents/Reports%20on%20RE/Using%20Modern%20Bioenergy%20to%20Reduce%20Poverty%20SEI%202001.doc.

Killick, Tony, and Qaim Shah. 2006. "Improving Aid Effectiveness: Implementing Paris Declaration." Pakistan Development Forum. Available from http://202.83.164.7/PDF/conferenceproceedings_pdf/Session-8-1.pdf.

Kojima, Masami. 2006. "Pakistan Household Use of Commercial Energy." World Bank/Energy Sector Management Assistance Project. Available from http://wbln0018.worldbank.org/esmap/site.nsf/files/320-06+Final_For_Web.pdf/$FILE/320-06+Final_For_Web.pdf.

Pakistan, Government of. 2003. "Accelerating Economic Growth and Reducing Poverty: The Road Ahead." Poverty Reduction Strategy Paper. Available from http://siteresources.worldbank.org/PAKISTANEXTN/Resources/PRSP.pdf.

Pakistan, Government of. 2005. "Economic Survey of Pakistan 2005-6." Available from http://www.finance.gov.pk/survey/home.htm.

Pakistan, Government of. 2006. "Approach Paper – Strategic Directions to Achieve – Vision 2030." Available from http://www.pakistan.gov.pk/ministries/planninganddevelopment-ministry/vision2030/approach%20paper/Approach%20Paper.pdf.

Pakistan, Government of, United Nations Development Programme and the United Nations Office for Project Services. 2003. "Pakistan Human Condition Report." Available from http://www.un.org.pk/undp/sl/sl-paf-pak-01-010.doc.

Pakistan, Government of, United Nations Development Programme and the Center of Research on Poverty Reduction and Income Distribution. 2004. "Pakistan Millenium Development Goals Report." Available from http://www.pakistan.gov.pk/ministries/planninganddevelopment-ministry/vision2030/approach%20paper/Approach%20Paper.pdf.

Pakistan, Government of, United Nations Development Programme and the Center of Research on Poverty Reduction and Income Distribution. 2005. "Pakistan Millenium Development Goals Report." Available from http://www.un.org.pk/undp/publication/PMDGR05.pdf.

Round, Jeffery, and John Whalley. 2002. "Globalization and Poverty: Implications of South Asian Experience for the Wider Debate." Available from http://www.gapresearch.org/production/JJoverview.pdf.

Shukla, P.R. 1997. "Biomass Energy Future for India." Indian Institute of Management, Ahmedabad. Available from http://www.decisioncraft.com/energy/papers/ecc/re/biomass/bei.pdf.

United Nations Development Programme. 2003. "United Nations Human Development Report." Available from http://hdr.undp.

org/reports/global/2003/.

United Nations Development Programme. 2004. "United Nations Human Development Report." Available from http://hdr.undp.org/reports/global/2004/.

United Nations Development Programme. 2005. "United Nations Human Development Report." Available from http://hdr.undp.org/reports/global/2005/.

United Nations Development Programme. 2004. "Reducing Rural Poverty through Increased Access to Energy Services: A Review of the Multifunctional Platform Project in Mali." Available from http://www.energyandenvironment.undp.org/index.cfm?module=Library&page=Document&DocumentID=5110.

World Bank/Energy Sector Management Assistance Project. 1994. "Pakistan Household Energy Strategy Study (HESS): Core Recommendations for Strategy Formulation." Prepared for the Government of Pakistan.

World Bank. 2002. "Pakistan Poverty Assessment." Available from http://lnweb18.worldbank.org/SAR/sa.nsf/Countries/Pakistan/52F7CDA6EE7FE78485256C680014813E?OpenDocument.

World Bank. 2005. "World Development Report – A Better Investment Climate for Everyone." Available from http://web.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2005/0,,menuPK:477681~pagePK:64167702~piPK:64167676~theSitePK:477665,00.html.

World Conservation Union. 2000. "Balochistan Conservation Strategy: An Overview." Available from http://www.iucn.org/places/pakistan/bcs.htm.

SOCIAL AND GENDER ISSUES IN PAKISTAN'S ENERGY SECTOR

DOROTHY LELE

When energy analysts are asked how Pakistan can meet its energy needs, they begin by aggregating the current consumption of commercial energy carriers across all sectors and forecasting demand on the basis of current patterns for various future periods. Because of the huge resulting energy requirements, the focus is then on large-scale energy projects to meet the forecasted need.

This macro-level supply focus neglects the demand side—how energy choices vary between social groups and regions, how consumption changes according to the situations of the users, and how consumers can be assisted to optimize their energy use and to move away from damaging fuel use. It also neglects the enormous potential of smaller-scale, localized and environmentally-benign technologies.

This essay outlines some important issues on the demand side that need to be resolved, if the energy needs of all Pakistani citizens are to be met efficiently, and with sustainability and minimal environmental costs.

Dorothy Lele is a social development specialist with twenty years of experience as an independent consultant on international projects and programs, specializing in gender equality and energy use. Since 1985 she has worked with development agencies such as the Canadian International Development Agency (CIDA) and the Department for International Development in the U.K. From 1996 to 1999, she was a gender equity specialist on the project team for CIDA's Pakistan Oil and Gas Sector Program. In 2004-05 she worked as a socio-economic and poverty specialist in Madhya Pradesh, India, focusing on socio-economic issues in tariff design for the electric power sector. She holds an M.A. in international affairs from Carleton University.

Biomass Energy Use

Traditional fuels still account for almost half of Pakistan's total energy consumption: about 22 million tons of oil equivalent (TOE) compared with primary commercial energy consumption of 51 million TOE.[1] When biomass is included in the calculation of energy use, the share of industry and transportation in total energy consumption falls from 70 to 44 percent while the share of the residential sector increases from 23 to 52 percent (see Table 1). This clearly demonstrates the continuing importance and pervasiveness of biomass energy sources.

Given that modern fuels are so much more efficient and convenient than biomass fuels, the common assumption is that any household given a choice would switch away from biomass as soon as commercial energy sources become available and affordable. This has not happened, however, especially in rural areas, and even at higher income levels. A major World Bank review of Pakistan's oil and gas sector pointed out that "biomass is the primary household fuel among rural households *irrespective of income*, and its use is essentially uniform across all income groups."[2]

The main reason for the continued dependence on biomass in rural areas is its availability and use outside the market, its only cost being that of the labor used in collecting it. Due to underemployment, labor is undervalued. Women provide most of the human labor involved in collecting and processing biomass fuels, but this is not counted in energy sector analysis, since it is unpaid and unseen. With no data on this contribution, the opportunity costs of biomass supply are invisible.

Another important reason for the continuation of biomass use,

Pakistan: Key Development Indicators

Population: 151.8 million (2003)
- 34.1% urban
- 2% annual pop increase
- 39.5% under age 15

Per capita GDP: US $555

Below Poverty Line: 32.6%

Percentage share of income
of the richest 20%: 42.3%
of the poorest 20%: 8.8%

Literacy: male 61.7%; female 35.2%

Ratio of female to male earned income: .34

Female professional & technical workers: 26%

Source: UNDP Human Development Report 2005

Table 1. Energy Consumption by Economic Sector

	Without Biomass*		With Biomass**	
	Metric tons of oil equivalent (x 1000) 1999		Metric tons of oil equivalent (x 1000) 1999	
Industry	8,663,489	34.3 %	13,247	26.7 %
Transportation	8,784,698	34.7 %	8,612	17.4 %
Residential	5,709,392	22.6 %	25,801	52.0 %
Agriculture	675,026	2.7 %	746	1.5 %
Commercial & public services	1,452,098	5.7 %	1,171	2.4 %
Total final energy consumption	25,257,300	100.0 %	49,577	100.0 %

Sources: *Pakistan Energy Yearbook 2000 ***World Resources Institute at http://earthtrends.wri.org.*

even by those who can afford alternative fuels, is that the best alternatives are not always available in rural areas. Natural gas is limited to urban and peri-urban areas and liquefied petroleum gas (LPG) is not widely available, since "the low population density in rural areas, low LPG uptake and low consumption among those who sign up for LPG make it difficult to establish commercially viable LPG distribution networks. The lack of economies of scale in catering to rural domestic consumers is the most important factor hindering ready access to LPG."[3]

The lowest income groups in urban areas also depend mostly on biomass for cooking and heating, even though they have to purchase it, mainly due to the high start-up costs and lump sums required for natural gas and LPG.

Most biomass energy is used by women for cooking. How does the predominance of women in biomass use contribute to the continuation of its use? When women's labor is not valued, the time and effort they spend on fuel collection and food preparation are not seen as important in decisions on household expenditures, so improvements in their—conditions of work are not made. If women had better access to information and a stronger role in household and community decision-making, their fuel use would be likely to change.

In the case of fuel-efficient and smokeless stoves introduced by the Escorts Foundation near Lahore, for example, men are included in the information and training sessions. The household adoption rate in most villages is 70-80 percent where the program is available. Positive impacts of the new stoves include improved kitchen management and hygiene, savings in fuel, time and effort, and improved gender relations. "Women say that their hands, walls and pots and pans are now clean and easier to wash. Women have also reported improved relationships with men as they are getting well-cooked and hot meals on time, made possible by the use of two burners at a time. Fuel wood consumption has reportedly been reduced to nearly one-half the previous average of about five kilograms per day per household."[4] And the stoves are not subsidized.

Switching to improved stoves is an important health measure as well as fuel-saving. Current practices of biomass combustion have serious negative health effects, especially on women and young children, who spend large amounts of their time indoors exposed to a range of pollutants from the incomplete combustion of biomass fuels in inefficient three-stone stoves. Acute respiratory infections are becoming the number one killer of Pakistani children under five years old.[5]

Biomass energy will continue to play an essential role in energy use in Pakistan for many years to come. Given its importance for the majority of the population and especially for women, the exclusion of biomass energy from energy sector planning and programs and the lack of attention given to improved biomass use are critical social and gender issues. The government's focus on developing the supply of modern fuels is understandable in terms of the sector's market orientation and the benefits of modern fuels, but this focus neglects the barriers involved in their adoption by large segments of the population, and the urgent need for improving current damaging fuel-use practices.

Energy for Poverty Reduction

One third of Pakistan's population lives on incomes below the national poverty line (36 percent in rural areas), a huge waste of human potential and a major obstacle to the nation's development, not to mention the human suffering. Modern energy services can transform the lives of the poor by increasing the productivity of their labor, providing new employment opportunities, reducing the time spent in arduous tasks, as well as eliminating the damaging health effects of traditional stoves.

Poor people usually pay a higher proportion of their expenditures on energy, and much more per unit of useful energy service than the rich, because the technologies they use are "typically inefficient or low quality."[6] They cannot afford the capital costs of more efficient energy sources, start-up equipment and appliance costs, or even to buy the energy they use (i.e. fuel wood and kerosene) in higher volumes. A natural gas connection costs more than the total monthly household expenditure of the bottom income quintile.[7]

The capital and operating costs are not the only barriers the poor face. The poor may be excluded from electricity and natural gas networks due to housing quality that is below connection standards, the distance of their dwellings from a pole, or in urban slums, the lack of street addresses or official housing registration, as well as tariff structures and payment mechanisms that are not adapted to their situations. Agricultural laborers, for example, can lose a day's wages if they have to travel to pay their electricity bills.

Modern energy services contribute directly to economic growth and poverty reduction. They create opportunities for income generation and employment, reduce unit costs, and free up time for productive activities, in addition to essential contributions to improved health and nutrition. "The use of more efficient fuels can reduce the large share of household income spent on cooking, lighting, and keeping warm, thus saving families much needed income for food, education, health services, and other basic needs."[8]

Women and men use energy services differently according to the needs of their gender-specific roles and responsibilities, both in the workplace and at home. Women's responsibilities for family nurture—health, nutrition and sanitation—are crucial for human development, but since this work is unpaid, it is usually undervalued and unsupported with services and tools that could greatly increase its efficiency and effectiveness. Women in low-income households are often caught in a vicious cycle of illness, low productivity and lack of the resources they need to change their situation.

Another key issue is that existing subsidies, that are meant to promote access of those with a low capacity to pay, do not always achieve their purpose. Natural gas, for example, is by far the cheapest source of modern fuels once a household is connected, with over 90 percent of the gas sold to households under the subsidized tariff of the first two slabs. Because of the high costs of connection, it is the higher income groups that are benefiting from this subsidy. "Fewer than 20 percent of Pakistani households use natural gas, and they belong largely to middle and upper income groups in urban areas." [9]

Even as private sector involvement is being welcomed as a means of providing energy services more efficiently, there is a serious potential that privatization could limit the access of poor households to energy services. Private companies have little motivation to provide services to the poor, with their precarious incomes, low consumption and inability to pay the full cost of service. Explicit policies and regulatory instruments are needed to support the access of poor households, and "targeted subsidies will be needed in many instances."[10]

If additional efforts can be made, by NGOs for instance, to assist the poor in using modern energy services for increased and improved livelihoods, they will be able to transform their lives, switch to modern energy carriers for household use, and, as they gain more secure incomes, to pay unsubsidized energy tariffs.

In order to capture the potential contributions of modern energy services towards poverty reduction, much more attention needs to be given to the many possibilities for pro-poor energy interventions identified in the 2005 United Nations Development Program and Energy Sector Management Assistance Program report on energy services needed to meet the Millennium Development Goals.[11]

USER PARTICIPATION

Many of the customer-related problems encountered by large energy providers are directly related to their lack of accountability to users. Most state-run electricity utilities in South Asia, for instance, have major problems with revenue collection and power theft that are very difficult to solve under their existing management models. They are finding themselves in a vicious cycle of revenues that are inadequate to meet costs, decreasing financial support from government, pressure to extend their services, and lack of funds to rehabilitate and maintain infrastructure and to pay staff adequate salaries, with the result of deteriorating service quality, accompanied by customers' increasing lack of willingness to pay for poor service. The utilities' only means of combating theft and enforcing payment compliance is through punitive measures that require additional staff.

From the residential users' point of view, the service is poor, unreliable and not worth the required payments. They find themselves faced with frequent outages, inconvenient payment facilities, billing errors that are difficult to rectify, poor response from customer service units, and demands for illegal payments from utility staff. Their relationship with the utility becomes antagonistic rather than cooperative and responsible.

These accountability, service and financing problems have been solved by management models that directly involve the users. The active participation of customer representatives is a crucial feature of successful models of central grid-based rural electrification, such as Bangladesh's Rural Electrification Board and rural electric cooperative societies in India, as well as off-grid centralized rural electrification, such as Village Hydro cooperatives in Nepal and Sri Lanka.[12] The treatment of the customer as the most important stakeholder is an obvious but overlooked element of their success. Entrepreneurs and NGOs are now successfully providing energy alternatives, based on users' participation in project development, design, implementation and management.

The traditional model of a utility-based centralized grid has also been challenged by the advent of new technologies. Gas-turbine generation has begun a trend toward smaller generators closer to users, changing electricity systems away from the traditional centralized configuration to a more decentralized one. Centralized grid extension can no longer be expected to reach all remaining communities unconnected to electricity grids, since long distances and low demand make this approach "prohibitively expensive for many rural areas. Village level mini-grids utilizing the most appropriate resources available—wind turbines, for example, or small-scale hydropower or diesel generators—may provide a more cost effective alternative, especially for compact, high-density settlements."[13]

Decentralized, user-managed systems have several advantages over centrally-managed ones. The users are known and accountable to each other; responsibility for breakdowns and repairs is easily assigned; decision-making is close to the users through their own representatives; and unreliable grid power can be supplemented by backup systems. Decentralized systems allow local control over choices between supply options and community priorities, improved billing and collection, direct accountability and increased control over illegal use. For a utility, selling to one local-level distributor at a bulk rate eliminates many billing and collection issues. Whichever the management model, users need to be effectively informed and involved in management decisions in order to contribute to the improvement, financial viability and sustainability of the service.

SOCIAL AND GENDER IMPACTS OF ENERGY SITE DEVELOPMENT

Another major social and gender dimension of the energy sector is the local effects of energy site development and operations. The extraction and conversion of energy resources and the operation of energy systems have major impacts on local communities. There may be population displacements and disruption or damage to the ecosystems and resource base upon which local communities depend. People often lose valuable agricultural land or their main sources of fuel wood, livestock grazing, fishing, and medicinal plants, which, given current population pressures, cannot be replaced at the same qualitative level.

There may be some new jobs as a result of the project, but the better ones usually go to skilled workers from elsewhere. Camps or housing colonies set up for project workers can become a source of income for local small businesses providing services, but they can also have negative effects by disrupting communities and introducing unwelcome practices such as gambling, prostitution and alcohol use. Disruption and displacement are generally worse for the poor, since they have few resources to draw upon, if any, and have great difficulty in reestablishing their livelihoods. Women are often severely affected through the disruption of their social networks and support systems.

Instead of these common negative effects, the development of energy resources can be an opportunity for initiating the sustainable development of local communities through substantively involving the local people in planning, implementing and monitoring the local impacts of a project. This requires more effort, genuine commitment, financial resources and patience, but yields much more effective and sustainable results. Most internationally active companies have now made commitments to, and developed policies on, their corporate social responsibility to operate in ethically, socially, and environmentally responsible ways. It is important to allow representatives of all the different social groups in the community, including women from those groups, to identify the relevant needs, priorities and methods of compensation. If only the project and village leaders are involved, the plans may exclude the needs and interests of disadvantaged and marginalized groups, including women. If community groups can be effectively involved, they can play a critical positive role in rebuilding the area, creating a constructive relationship with the proponent that maintains their license to operate.

There are two examples of successful community involvement reported on the internet. A local organization, Ghazi Barotha Traqeiyati Idara, was created by Pakistan's Water and Power Development Authority (WAPDA) and the donors of the Ghazi Barotha Hydropower Project "to facilitate and mediate relations between the different governing bodies and communities."[14] The second project is that of the BHP Billiton company and its community development program around the Zamzama Gas Field.[15] The description of the efforts undertaken for both these projects indicate their resounding success, but the only meaningful assessment of outcomes would be from the groups affected. If they were fully involved as is claimed, then they are probably satisfied with the outcomes, and may be continuing their own efforts to improve their communities. At a broader level, continuing problems with sabotage of gas pipelines in Balochistan illustrates the local and regional dissatisfaction and hostility generated by developing and using resources without providing adequate benefit and compensation to the communities from which the resources are drawn.[16]

WOMEN IN THE WORKFORCE

Women make up half of Pakistan's human resources, and, in 2005, they accounted for 26 percent of Pakistan's professional and technical workers.[17] When women's talents are developed and they have dignified working conditions, they can contribute a great deal to their workplaces. Leading companies in Pakistan's oil and gas sector have adopted policies to attract more women, because they need the best talent available and because they have recognized that workforce diversity contributes to creativity and new ideas, which are essential in the industry's increasingly competitive work environment.[18]

A 1997 survey conducted by the Oil and Gas Sector Program (OGSP), a project funded by the Canadian International Development Agency (CIDA), revealed that 669 women employed across 31 public and private sector companies in Pakistan's oil and gas sector comprised 2 percent of a workforce of 33,380 people. Women accounted for 1.4 percent of public sector and 3.7 percent of private sector employees. Thirty-one percent of these women were professionals, most of them specializing in human resources, medical, teaching and financial fields, including 15 of them in technical specializations.

There is a great deal of human potential available, given the talented pool of female students, their interest in technical areas, and their capacity for the work. Female students are often the top performers in their classes, including those in the energy sector's technical fields. An internship program for top-level female graduates, offered by the OGSP, provided a highly successful channel to introduce bright young women into the male-dominated oil and gas industry.

Major barriers obstruct women's equal participation in the energy industry. Organizational cultures within energy sector companies are dominated by values, beliefs and behavioral patterns that discourage women's full contribution, and can even be hostile to women. Recruitment and selection processes often present major institutional barriers for women. The lack of alternative work schedules such as job-sharing and part-time positions, and of child-care arrangements, substantially impedes women's equitable participation and advancement in the energy industry.

An important issue for professional women working in the energy industry is that high mobility and field experience are often critical requirements for career advancement. The mobility requirements in gaining such field experience present another barrier for women, due to their major responsibilities for child and domestic care.

In addition to their potential contribution to professional fields, women are also needed in many areas of customer services that deal with household consumers. Since women are the major energy users in the home, and since they cannot be directly approached by male service technicians in Pakistan, female staff are needed if any significant change is to be made in household energy use.

GENDER AND ENERGY

Gender issues can be considered in the context of broader social issues, but many analysts argue that, due to their serious developmental consequences, they need to be treated separately. The major gender and energy issues are:

- energy use:
- differences in men's and women's energy use and differential attention to and treatment of them;
- energy supply:
- the major role of women in procuring biomass energy and the widespread neglect of this role;
- differential participation of men and women in the energy sector workforce and decision-making.

There have been several important gender and energy initiatives in Pakistan since the late 1990s. The Pakistan Petroleum Women's Network was established in 1997, with the assistance of CIDA's Oil and Gas Sector Program. It brought together professional women in the oil and gas sector to share common experiences and to provide a forum for working towards meeting their needs and aspirations.

Gender advisors have been included in the planning processes of the last two five-year plans, assigned to assist energy working groups to engender the energy sections of the plans. The Interagency Network on Gender and Development provided several important recommendations for infrastructure sectors, including energy, in the Poverty Reduction Strategy Paper, but only those in the social sectors have been used. Since there have been no budgetary allocations for these recommendations, very little has been done.

ENERGIA, the International Network on Gender and Sustainable Energy, based in the Netherlands, along with the Aga Khan Rural Support Program, organized a workshop in June 2004 to identify gender and energy issues in Pakistan and to assist in establishing a national network on gender and energy.

The issues have been well-defined; it is now a question of recognizing their importance and assigning responsibilities and budgets to address them.

CONCLUSION

No one disputes the fact that Pakistan will require massive investments in energy infrastructure to meet growing energy demand over the next thirty years. The question is how to guide investment in such a way that it promotes all Pakistan's development objectives, human, social and environmental, as well as economic growth. This requires that the issues outlined in this paper need to be addressed in the government's policy analysis and planning processes. The government needs to define clear social, poverty and gender objectives for the energy sector, as well as economic and environmental objectives, use them in all policy development, and include them in its policy directives to energy regulatory agencies.

A major part of the problem (of the neglect of energy sub-sectors and disadvantaged social groups) is the institutional fragmentation of the energy sector and its lack of linkages with the sectors it is meant to serve, such as health, education, water supply, and transportation. There is an urgent need for increased communication and coordination among energy, agricultural and forestry ministries and agencies responsible for energy technologies, on one hand, as well as with the ministries depending on reliable energy services for their own programs and services.

Bigger is not necessarily better. Energy technologies are changing, and the harmful effects of carbon emissions are increasing. We must remember that energy is a means to development ends, not an end in itself. In order to maximize efficiency and to provide appropriate choices for consumers, the planning process should start with the needs and end-uses of different user groups and take into account locality, local resources and users' situations in setting policy frameworks.

For this, up-to-date data is needed, disaggregated by region, settlement size, income and gender. Representatives from all social groups need to be involved in the identification of development and energy goals and priorities. Energy development needs to be directed toward these overall goals through appropriate policy and institutional frameworks.

NOTES

1. M.A. Sheikh, Planning Commission of Pakistan, speaking at conference, *International Ministerial Conference on Nuclear Power for the 21st Century,* March 2005.

2. World Bank, "Pakistan: Oil and Gas Sector Review," July 10, 2003, http://lnweb18.worldbank.org/SAR/sa.nsf/Attachments/POGSR-2003/$File/POGSR-2003.pdf.

3. World Bank, "Pakistan: Oil and Gas Sector Review."

4. United Nations Development Program (UNDP)/Global Environmental Facility (GEF), *Success without Subsidy: A Case Study of the Fuel-Efficient Smokeless Stoves Project of the Escorts Foundation*, Final Report (Geneva: UNDP/GEF, July 2002).

5. World Health Organization (WHO), "Situation Analysis of Household Energy Use and Indoor Air Pollution in Pakistan," May 2006, www.who.int/entity/indoorair/publications/energypakistan/en/index.html.

6. Department for International Development (DFID), "Energy for the Poor: Underpinning the Millennium Development Goals," August 2002, http://www.dfid.gov.uk/pubs/files/energyforthepoor.pdf.

7. World Bank, "Pakistan: Oil and Gas Sector Review."

8. Vijay Modi, Susan McDade, Dominique Lallement, and Jamal Saghir, "Energy Services for the Millenium Development Goals," (Washington, D.C. and New York: United Nations Development Program (UNDP)/Energy Sector Management Assistance Project (ESMAP), the UN Millennium Project and the World Bank, 2005), http://wbln0018.worldbank.org/esmap/site.nsf/files/UNDP-MP-WB-ESMAP.pdf/$FILE/UNDP-MP-WB-ESMAP.pdf.

9. World Bank, "Pakistan: Oil and Gas Sector Review."

10. Thomas B. Johansson and Jose Goldemberg (eds.), *Energy for Sustainable Development: A Policy Agenda,* (Geneva: United Nations Development Program (UNDP), International Institute for Industrial Environmental Economics (IIIEE) and the International Energy Initiative (IEI), 2002), 10–11.

11. Vijay Modi, Susan McDade, Dominique Lallement, and Jamal Saghir, "Energy Services for the Millenium Development Goals."

12. United States Agency for International Development (USAID)-South Asia Regional Initiative for Energy Cooperation and Development (SARI Energy),

Rural Energy Services Best Practices, (San Francisco: Nexant Consulting, May 2002), http://www.sarienergy.org/ProjectReports/RESBestPracticesExecSum.pdf.

13. Johansson and Goldemberg, *Energy for Sustainable Development: A Policy Agenda*, 12.

14. Leadership for Environment and Development International (LEAD), "Sustainable Community Development on the Potohar Plateau: Building Bridges Between Hydropower and Freshwater Conservation," December 2004, http://casestudies.lead.org/index.php?cscid=140.

15. BHP Billiton, "BHP Billiton Petroleum Operational and Financial Review 2005, Pakistan Factsheet on Zamzama Gas Field Phase I," 2005, http://www.bhpbilliton.com/bbContentRepository/ docs/OurBusiness/Petroleum/PakistanFactsheet.pdf.

16. See BBC, "Balochistan gas pipeline blown up," June 10, 2006, http://news.bbc.co.uk/2/hi/south_asia/5066818.stm.

17. United Nations Development Program (UNDP), *Human Development Report 2005*, (Geneva: UNDP, 2005), http://hdr.undp.org/reports/global/2005/.

18. Canadian International Development Agency (CIDA), Pakistan Oil and Gas Sector Program, *Gender Equality in the Oil and Gas Sector: International Comparisons and Lessons* (Ottawa: CIDA, 1999).

ENERGY AND THE PAKISTANI ECONOMY: AN EXPLORATORY ANALYSIS TO 2035

ROBERT LOONEY

With rapid economic growth in recent years, Pakistan's demand for energy has been increasing at the rate of 10–12 percent per annum. However, the country's rather static oil, hydroelectric power, and gas reserves have raised serious concerns as to the sustainability of the current economic expansion, as well as future economic growth. The gap between Pakistan's energy use and the country's ability to produce energy has widened in an alarming way in recent years.

As a means of responding to the country's lagging energy supply, Pakistan's government has drawn up a 25-year plan (2005–2030) for expanding energy production.[1] Initial cost estimates are staggering—these range from $37–$40 billion, with an average annual investment of approximately $1.5 billion. Given the country's low rate of domestic savings, much of this expense will have to be met by increased flows of foreign aid, external borrowing, and foreign direct investment—all of which can be somewhat problematic due to the country's volatile political situation, internal strife, and its competitive disadvantage vis-à-vis more dynamic emerging markets.

Pakistan's energy plan provides an excellent overview of the challenges facing the country over the next several decades, and it provides a sound, practical framework for identifying short-term, as well as medium- and longer-term, needs. The emphasis on developing indigenous sources of energy is sound, especially in light of the country's vast coal

---

Robert Looney is professor of national security affairs at the Naval Postgraduate School in Monterey, California, specializing in economic issues related to the Middle East and South Asia. He has also served as a consultant to several national governments and international organizations. He is the author of 20 books, including *The Pakistani Economy: Economic Growth and Structural Reform* and *Manpower Policies and Development in the Persian Gulf Region.*

deposits and hydroelectric potential. On the other hand, one might question several of the key assumptions upon which the plan is based. The plan assumes high sustained rates of economic growth—the norm for the future is listed as 7.5 percent. This pace of economic expansion in turn defines many of the country's future energy requirements and the proper timing for project implementation.

High sustained growth has not been achieved in the past and, unfortunately, it is unlikely to be the dominant pattern in the foreseeable future.[2] Instead, the pattern has been one of roughly a decade of expansion followed by a decade of rather flat growth rates.[3] Patterns of this type, if they continue into the future, will create a somewhat different mix of energy requirements than those envisaged by the government's energy plan. Also unclear is the likely pattern of future energy prices—how sensitive are the assumed energy supply/demand balances to alternative energy scenarios? Clearly, these will also have a great effect on both the country's supply of and demand for commercial energy.

Taking the cyclical nature of Pakistan's economic performance into account, the sections that follow attempt to sketch out several alternative scenarios of growth and energy needs. In particular, what are some of the key interrelationships between sources of energy demand and supply? What are the economic growth consequences of alternative energy availabilities, and in turn how do these growth patterns affect the subsequent energy supply and demand patterns? What energy strategies are suggested by the interconnection between the country's growth requirements and energy needs? Are these significantly modified under rising or falling energy prices?

A Macroenergy Forecasting Model

The main features of the macroenergy forecasting model include:

1. Expanded per capita income is assumed to be a function of energy availability and capital formation. Statistically, gas, coal, and hydroelectric generation—in addition to capital formation—have the strongest statistical links to per capita income.

2. In turn, per capita income affects both the demand for total energy as well as domestic sources of energy.

3. The world dollar price of oil multiplied by the rupee exchange rate was found to be statistically significant in a number of energy supply and demand relationships.

4. A number of energy demand relationships are competitive—expanded use of one type of energy comes at the expense of another. Also, several types of energy expansion discourage output increases in others. Complementarities also exist between different types of energy on both the demand and supply sides.

Next, seven different energy/investment scenarios are considered, each based on different assumptions concerning patterns and rates of investment and energy availability. These scenarios are constructed in a manner that assures that overall per capita income increases improve over their historical patterns. More importantly, energy expansion is not looked at just in terms of specific power outputs. Rather, the models attempt to show the likely manner in which different investment/energy supply mixes interact with the overall economy to produce higher standards of living.

Model One: Base Line Forecast—Consolidated Growth

In this scenario, gross capital formation and the three key energy variables are assumed to expand at a rate of 3 percent per annum. This forecast is assumed to be the worst case scenario—the current growth phase ends, and resource constraints and perhaps political uncertainties undermine efforts to attract foreign investment and aid. However, investment or energy availability does not decline as dramatically as in the 1970s or 1990s. Growth largely occurs through consolidating and extending various economic and governance reforms.

Model Two: Continuation of the Historical Pattern of Cyclical Growth

The current growth phase extends to 2010, followed by flatter growth up to 2020, and then another expansion and a leveling off in the 2020–30 and 2030–35 periods. The assumed values for the growth of gross capital formation and the energy components for the periods 2006–10, 2011–20, 2021–30, and 2031–35 are as follows: gross capital formation, 4 percent, 2 percent, 4 percent, and 2 percent; gas, 10 percent, 7 percent, 10 percent, and 7 percent; coal, 4 percent, 11 percent, 4 percent, and 11 percent; and hydrogeneration, 6 percent, 4 percent, 6 percent, and 4 percent.

Model Three: Historical Pattern of Cyclical Growth but with Political Opposition Preventing a Major Expansion in New Dam Construction

In this scenario, efforts to overcome regional opposition to new dams fail. As a result, hydroelectric generation expansion is limited to 3 percent per annum. Other variables are assumed to expand as in Model Two.

Model Four: Government Investment-Led Growth, but with Emphasis on Social Programs

In this scenario, the country is able to attract and mobilize sufficient resources to sustain rates of gross capital formation at 6 percent. However, a shift in expenditure priorities allocates a larger share of government resources to social investments—education, health, etc., rather than energy. The private sector is left to fund added investment in the energy sector. The private sector responds with gas and coal expanding at 7 percent and 5 percent respectively, but hydroelectric generation expands in line with the historical pattern assumed in Model Two.

Model Five: Private Sector-Led Growth

As in Model Four, the private sector mobilizes sufficient resources to expand gas and coal supplies by 7 percent and 5 percent per annum over the period to 2035. However, the public sector, unable to pursue adequate tax reform, is constrained to its historical cyclical pattern of investment. As a result, gross capital formation and hydroelectric generation are assumed to expand as in Model Two.

Model Six: Expanded Dam Construction and Hydroelectric Capacity

Political impediments to new dam construction are overcome; the World Bank and other donors supply adequate funds for a major expansion of the country's hydroelectric generation capacity. Gross capital formation increases at 6 percent per annum with hydroelectric generation expanding as follows: 2006–10, 5 percent; 2011–20, 7 percent; 2021–30, 9 percent; and 2031–35, 11 percent. The vast expansion in hydroelectric capacity lessens the perceived profitability of investment in coal and gas development. Total supplies of these energy sources are assumed to expand at rates of 3 percent per annum over the period to 2035.

Model Seven: Coal/Gas-Led Energy Expansion

For some of the reasons noted above, hydroelectric expansion is constrained and overall investment levels follow the historical cyclical patterns. Concerns over energy shortages, however, lead to the creation of a number of incentives for investment in coal and, to a lesser extent, gas. Total supplies of these two energy sources are assumed to expand at rates of 7 percent per annum during the forecasting period.

OUTCOMES

Two sets of forecasts were made. The first one was made under the assumption of gradually falling oil prices—with the world oil price, converted to rupees, declining at an average rate of 3 percent per annum over the forecast period. The second forecast was made in an environment of gradually rising oil prices, at 3 percent per annum. Several distinctive supply/demand patterns emerge:

Model One

At low rates of economic growth and falling oil prices, gas supplies would run well below demand in the years up to 2030. Electricity supplies would be short of anticipated needs between 2010 and 2020 and perhaps again after 2030. Considerable amounts of coal are currently imported, but these would likely decline in the early years. Coal shortfalls might appear after 2010, becoming particularly severe in the 2020s. The gap between the demand for oil/petroleum (that is, crude oil that is extracted) and the supply of refined petroleum products would be particularly severe in the early years—up to 2010. However, after 2010, supply and demand come more into balance.

With rising oil prices the situation changes dramatically. Gas supplies are roughly in line with demand throughout the forecast period. Coal supplies improve dramatically in the period up to 2010 and might not encounter shortfalls until the 2020s. Also, a big jump in thermal electricity generation relieves pressures in electricity markets throughout the forecast period. The oil/petroleum and petroleum products segment of the energy market follows essentially the same patterns experienced with falling oil prices—severe shortfalls in the period up to 2010, followed by a rough balance throughout the rest of the forecast period.

Model Two

A continuation of the country's pattern of cyclical economic growth during a prolonged period of falling oil prices produces a sharply contrasting picture. Domestic gas production lags considerably behind demand throughout the forecast period up to 2030. Electricity supplies might be adequate up to 2010, but they would experience a severe shortfall up to 2020, remaining in rough balance for the rest of the forecast period. Coal supplies are also adequate up to 2010, but they might experience shortfalls after that date. As with Model One, the gap between oil/petroleum and petroleum products is severe in the early years, but not after 2010.

With rising oil prices, domestic gas supplies improve dramatically. However, the demand for gas also increases somewhat. The net result is a shortfall throughout the entire forecasting period, with the shortfalls becoming particularly severe in the 2020s and extending into the early 2030s. Electricity supplies also expand, but not enough to stave off severe shortfalls in the 2020s. In contrast, coal follows a pattern similar to what might be expected in a period of falling prices—initial surpluses, followed by a long period of rough supply/demand balance, with perhaps demand slightly outrunning supply. Oil/petroleum and petroleum products fluctuate between severe shortages in the initial years; balance up to 2020; surpluses in the 2020s; and deficits in the early 2030s.

Model Three

In an era of falling energy prices and with hydroelectricity held at low levels of expansion, electricity experiences shortfalls up to 2030, with the gap between demand and supply especially severe in the 2020s. Domestic gas supplies are also inadequate throughout the forecast period. The pattern is one of moderate shortfalls up to 2010, gradually worsening up to 2030. In contrast, coal might not experience a shortfall with regard to demand until the 2020s, with supply outrunning demand again in the early 2030s. Oil/petroleum and petroleum products are again in deficit in the early years; roughly in balance up to 2020; and showing large surpluses in the 2020s. Deficits, however, return in the early 2030s.

With rising oil prices, thermal electricity expands sufficiently to meet domestic demand. However, a shortfall is likely in the 2030s, with demand again surpassing supply. Coal production expands faster than demand in the early years, significantly reducing imports. After 2010, supply and demand are in rough balance. Although gas production again increases with rising oil prices, production increases lag behind expanded demand throughout the period up to 2035. The gap between demand and supply becomes particularly large in the 2020s. Oil/petroleum and petroleum products continue their fluctuating pattern of alternating deficits and surpluses, beginning with large deficits in the period up to 2010.

Model Four

High rates of overall national investment produce another unique pattern of energy balances. With falling oil prices, the gaps between demand and supply are generally lower than in the two previous models. After an initial period of early shortfalls, gas production expands to meet demand over the remainder of the forecast period. In addition, over the whole forecast period electricity supplies also expand at a slightly faster rate than demand. The same is true for coal, with the exception of a slight supply shortfall in the early 2030s. Even the fluctuations in oil/petroleum and petroleum products are dampened, especially after an initial period of sharp shortfalls.

Rising oil prices do not fundamentally alter this picture. Instead, in most cases supply improves slightly relative to demand to further relieve pressures in the energy markets.

Model Five

This model is characterized by the assumption that there is a limited availability of coal (due to possible delays in bringing new sources into production), together with a cyclical pattern of investment similar to that experienced in the past. If oil prices experience a gradual decline, energy supply and demand balances are not particularly favorable. A sizeable gas shortfall occurs in the early years to 2010, increasing somewhat in the years to 2020 and then continuing to 2035. After an initial period of coal production expanding faster than demand, it also experiences shortfalls to the end of the projection period. However, these may not be as significant as those associated with gas. After an initial surplus, terminal electricity expansion lags behind expected need, although this may be largely made up with the anticipated expansion from hydro sources. After an initial deficit, only oil/petroleum and petroleum products experience sustained periods of domestic supply exceeding demand.

While Model Five produces a very favorable set of energy balances for falling oil prices, the shifts in demand toward gas, coal, and electricity with rising oil prices erode much of this potential gain. Gas demand consistently outruns supply, which is also the case for coal after 2010. Electricity follows the same path as coal. In this scenario the assumed expansion of hydroelectric sources—6 percent for 2006–2010, 4 percent for 2011–2020, 6 percent for 2021–2030, and 4 percent for 2030–35—may be sufficient to accommodate expanded demand. The oil/petroleum and petroleum products balance is also not as favorable as in the case of falling oil prices. Still, after an initial deficit experienced in other models, supply matches demand fairly closely until 2030, when it accelerates more rapidly.

Model Six

This model focuses on expanded hydro sources of electricity together with high overall rates of sustained investment. As noted earlier (first point, macroenergy model), this combination results in a sustained acceleration of per capita GDP after 2010. The resulting increase in demand for other energy resources—together with a stimulus to expand other sources of energy—produces a unique pattern of energy balances. After an initial shortfall of supply, the oil/petroleum and petroleum products balance is nearly equalized in the period up to 2020. Gas, on the other hand, experiences chronic shortfalls of supply—especially in the 2020s. Supplies of electricity should be adequate, especially in light of the acceleration in hydro sources. Still, thermal capacity is projected to lag somewhat behind overall electricity demand after 2010. Domestic coal expansion also fails to meet the expanded demand after 2010.

As in the earlier models, rising oil prices assist in bringing demand and supply more into balance. This is especially the case for gas and coal in the period up to 2020, although after that date demand significantly outruns supply.

Model Seven

This model assumes fairly abundant supplies of gas and coal, with investment less dynamic than in the previous model. This produces, except for the base line model, average rates of economic growth somewhat below most of the other models. As noted earlier, it produces higher rates of growth than the hydro strategy in the earlier years, but this growth flattens out in the latter years, falling considerably below that associated with a major expansion in dam construction. With falling world oil prices, this mix causes growth in domestic gas supplies to lag behind demand, especially in the 2020s. After expanding fairly rapidly in the early years, the expansion in domestic coal production also fails to keep pace with demand after 2010. In contrast, thermal electricity keeps up with demand in the early years, only to fall sharply behind over the period 2010–20. After that, demand and supply are fairly balanced until shortfalls occur again after 2030. Oil/petroleum and petroleum products revert to their normal pattern of supply, lagging behind demand in alternating decades.

Rising oil prices bring coal supply and demand growth largely into parity after 2010. The same is not true of gas, however, where shortfalls continue after 2010. Electricity also fails to keep pace with demand after 2010.

IMPLICATIONS

In summing up, which alternatives appear to be the best? While the government has limited control over the manner in which Pakistan's energy picture will unfold, several generalizations from the models examined above may provide some guidance.

If the goal is to improve energy balances, especially for coal, electricity, and gas, then high oil prices that encourage increased production are more conducive than declining prices. With the good chance of growth accelerating in Models Four, Six, and Seven after 2010, there is a possibility for the establishment of a virtuous circle in which expanded demand for coal, electricity, and gas increase profitability in these sectors, thus stimulating expanded investment and further growth.

While Pakistan's government has little control over international prices, it does control the rupee exchange rate. In this regard, Pakistan should not postpone devaluations, but instead allow the currency to transmit world oil price increases into the domestic market. In the future, the authorities should strive toward an energy pricing system that more closely reflects the true cost of energy.

If high sustained growth is sought, then an environment characterized by high rates of sustained investment together with hydro development (Model Six) may be the best course, especially if substantial loans from international agencies are forthcoming. This environment may be the most conducive to a virtuous circle.

Higher rates of GDP growth have other benefits. Ironically, lower rates of economic growth may be more plagued by energy imbalances than higher rates of growth. In the future, low rates of growth may compound this problem by making the country less competitive in attracting significant inflows of direct foreign investment.

If world oil prices fall for a prolonged period of time, the country should definitely pursue a high investment/growth policy such as that outlined in Models Four, Six or Seven. With falling profitability in oil, gas, and coal development and limited prospects for expansion in oil, private investment might not be sufficient to maintain high rates of sustained economic growth. The energy imbalances experienced at low rates of economic expansion would put stress on the country's balance of payments, further discouraging capital inflows to the country. In short, the high energy imbalances associated with low growth in an atmosphere of falling energy prices are conducive to the creation of a vicious circle.

ASSESSMENT

This paper is intended to be only an exploratory analysis of Pakistan's energy futures. As such, the forecasting model developed here provides only a rough order of magnitudes, and should be looked at as a very preliminary approximation of Pakistan's energy needs. Its strength lies in identifying areas of potential trouble and in illustrating the need for corrective policy responses.

On the other hand, the macroenergy model has a number of inherent weaknesses that need to be resolved before a high degree of certainty can be attached to its visions of the future. In particular, there are a number of inherent contradictions that need to be resolved, such as the inconsistencies that exist between the initial rates of growth of energy supplies and the subsequent demand for that type of energy at later stages of the model. Specifically, further work must be undertaken to show the precise manner in which the increased availability of various types of energy alters income streams and sector growth and hence the future profile of energy demand.

The model also implicitly assumes that a major goal of energy policy is to become less dependent on imported petroleum and petroleum products. Other objectives should be examined and their feasibilities assessed.

Additionally, while the model suggests certain policy actions, the impact of these measures is difficult to predict in any systematic way.

Finally, without a more extensive macroeconomic framework, it is difficult to assess the feasibility of sustained levels of energy imports to bridge the gap between demand and domestic supply. Under certain balance of payments situations, these shortfalls could be easily financed, while under others the same shortfalls would create a severe stress on the economy. Much depends on the availability of foreign direct investment and the extent to which these funds could be directed toward expanding domestic energy sources.

This final point leads to a general conclusion: what takes place outside the energy sector may have consequences that are just as important for the country's energy picture as are the policies and events that directly affect the energy sector.

NOTES

1. Useful summaries can be found in Shamim Ahmed Rizvi, "Energy Demand Growing in the Face of Static Reserves," *Pakistan & Gulf Economist,* April 3, 2006; Humayun Farshori, "National Energy Needs," Presentation to Pakistan Development Forum, April 26, 2005, http://siteresources.worldbank.org/PAKISTANEXTN/Resources/293051-1114424648263/Session-VII-Energy.

pdf; and Fahd Ali, “Pakistan’s Future Energy Needs,” *South Asian Journal,* July/September 2005, http://www.southasianmedia.net/Magazine/journal/9-pakistan_future_energy.htm.

2. See, for example, Shahid Javed Burki, “Pakistan’s Growth Story,” *Dawn,* March 28, 2006.

3. As documented in Robert Looney, “Failed Economic Take-Offs and Terrorism in Pakistan: Conceptualizing a Proper Role for U.S. Foreign Assistance,” *Asian Survey* 44 (November/December 2004): 771-793; and Robert Looney, “Pakistan’s Economy: Achievements, Progress, Constraints and Prospects,” in *Pakistan: Founders’ Aspirations and Today’s Realities,* ed. Hafeez Malik (New York: Oxford University Press, 2001), 195-243.

POWER SECTOR REFORM IN PAKISTAN: ISSUES AND CHALLENGES

Vladislav Vucetic and
Achilles G. Adamantiades

In 1992 the government of Pakistan approved a strategic plan for power sector restructuring and initiated a wide-ranging reform to address the persistent crisis in the sector. The main objectives were to increase investment, improve service, and strengthen the sector's financial performance, with particular emphasis on attracting private investors to help achieve these objectives. The twin task of executing a large investment program and implementing the reform plan presented difficult challenges. In retrospect, the sector responded with considerable success, especially on the investment side, doubling generation capacity, energy production, and number of customers, supporting economic growth, enabling better health and education, and bringing modernity to many Pakistani homes. The sector learned valuable lessons in dealing with private investors, implemented a number of steps toward structural and regulatory reforms, and enlarged the pool of talent in technical, commercial, and policy areas on which it can draw as it continues to develop.

Vladislav Vucetic is a lead energy specialist in the South Asia region of the World Bank. He has been with the World Bank since 1992 and has led or worked on the Bank's energy programs in Europe, Central Asia, East Asia, Africa, and the Middle East. He holds a doctorate degree in operations research from George Washington University. **Achilles G. Adamantiades** is a consultant in energy and the environment, concentrating on power development, renewable energy, power sector reform, and energy policy. He was a principal power engineer for the World Bank until his retirement in 1996. His doctorate is in nuclear engineering from the Massachusetts Institute of Technology. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors and do not necessarily reflect those of the World Bank.

Still, much remains to be done and some problems are appearing again. The full benefits of the reform program are yet to be realized, as some of its key provisions are awaiting implementation. Technical and commercial losses have not declined as much as they should have. The sector requires substantial financial support from the government, since the tariffs have not kept pace with rising fuel prices and other costs. The brisk economic growth during the last several years has led to a rapid increase in electricity demand and started again to strain the power system's ability to generate and deliver enough electricity to consumers, especially during peak demand periods, with an increasingly adverse impact on the quality and reliability of service.

This essay provides an overview of Pakistan's power sector and the issues it faces today, with particular emphasis on the status of the reform program and the remaining challenges of its implementation.

ELECTRICITY INDUSTRY STRUCTURE AND OWNERSHIP

Historically, Pakistan's power sector was organized into two state-owned, vertically integrated utilities:

- The Karachi Electric Supply Corporation (KESC), serving the city of Karachi and its adjoining areas (about 13–15 percent of Pakistan's power market); and
- The Water and Power Development Authority's Power Wing (referred to in the rest of the paper as WAPDA[1]), which served the rest of the country.

Both utilities have owned and operated generation facilities, as well as transmission and distribution networks. KESC still operates as a separate, vertically integrated utility, but is now predominantly in private hands, after 73 percent of the shares were sold to private investors in November 2005. WAPDA, however, was restructured into 15 incorporated entities, all of them state-owned, as follows:

- Four thermal generation companies (GENCOs): Jamshoro Power Generation Company (GENCO-1, 1024 MW installed/870 MW avail-

able), with headquarters at Jamshoro district Dadu, near Hyderabad in Sindh; Central Power Generation Company (GENCO-2, 1655 MW/1400 MW), with headquarters at Guddu, district Jacobabad in Sindh; Northern Power Generation Company (GENCO-3, 1856 MW/1700 MW), with headquarters at Muzaffargarh in Punjab; and Lakhra Power Generation Company (GENCO-4, 150 MW/120 MW) at Khanote in Sindh.
- A National Transmission and Dispatch Company (NTDC), in charge of operating the transmission system (220-kV and 500-kV network) and performing a dispatch function. Its headquarters are in Lahore, while the National Dispatch Center is in Islamabad.
- Nine electricity distribution companies (DISCOs), of which five are in the Punjab province (Islamabad Electricity Service Company—IESCO; Lahore Electricity Service Company—LESCO; Faisalabad Electricity Service Company—FESCO; Gujranwala Electric Power Company—GEPCO; and Multan Electric Power Company—MEPCO); one in Balochistan (Quetta Electricity Service Company—QESCO); one in Sindh (Hyderabad Electricity Service Company—HESCO); one in Northwest Frontier Province (Peshawar Electricity Service Company—PESCO); and one in Federally Administered Tribal Areas (Tribal Electricity Service Company—TESCO).
- WAPDA continues to operate hydropower plants.[2]

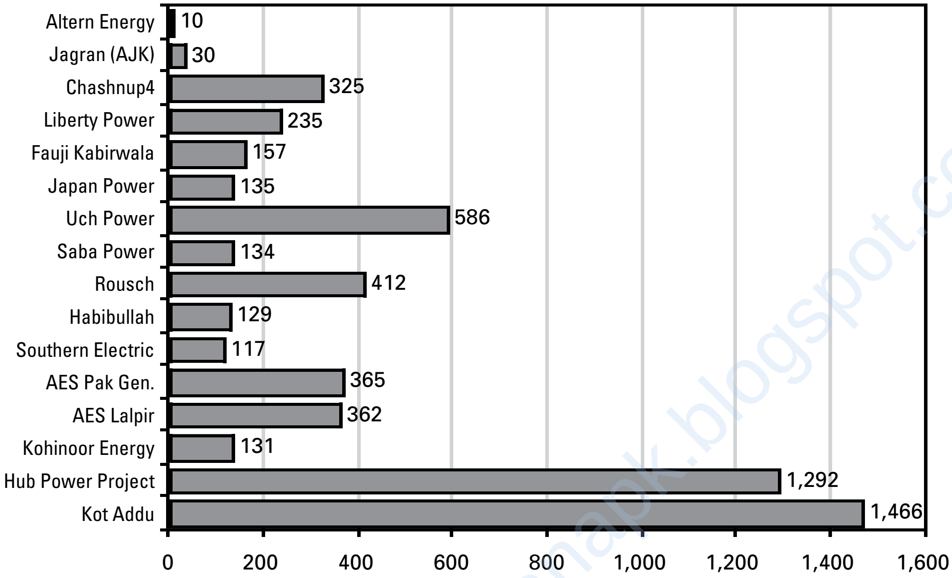
The private sector has made a robust entry into the system. As of the end of fiscal year 2005, there were 16 independent power producers (IPPs), with a collective capacity of about 5,832 MW. See Figure 1 for more details.

ELECTRICITY DEMAND AND SUPPLY

Demand

The accelerating economic growth and rate of electrification have led to a commensurate increase in electricity demand in recent years. In contrast to the average growth rate of 3.3 percent during 1997-2002, Pakistan's economy grew by 6.4 percent in FY 2004 (July 1, 2003–June 30, 2004) and 8.4 percent in FY 2005. The peak electricity demand

Figure 1: Independent Power Producers and Respective Installed Capacities in MW



in the country in FY 2001 was 11,463 MW and energy consumption was 65,751 gigawatt hours (GWh); by FY 2005 these figures reached 14,091 MW and 85,629 GWh,[3] a cumulative growth of 23 percent and 30 percent, respectively. The peak demand growth was especially high in recent years: 6.35 percent in FY 2004 and 8.22 percent in FY 2005, almost identical to gross domestic product (GDP) growth rates. There is a general consensus that demand will keep increasing at a similar pace in the short to medium term, although the rates differ from one forecast to the other. The projections developed by WAPDA show peak demand reaching 20,160 MW in FY 2010—a compound rate of increase of 7.4 percent—and exceeding 44,000 MW by FY 2020. A similar indicative forecast is used by the Private Power and Infrastructure Board (PPIB),[4] which shows that the peak demand will already exceed Pakistan's firm power supply—limited according to PPIB figures to slightly above 15,000 MW—in 2006. The government's Medium Term Development Framework, 2005-2010, has developed four scenarios, with projections for peak power demand in 2010 ranging from 18,670 MW to 22,740

MW and in 2020 from 28,770 MW to 72,000 MW. Common to all of these forecasts is that electricity shortages will appear between 2006 and 2008 unless new capacity is added to the system.

The number of end consumers has been steadily increasing as well, at a 5 percent compound rate between 1995 and 2004, reaching 15,840,811 (14,091,338 in WAPDA, the rest in KESC), of which 13,086,453 were residential (11,737,078 in WAPDA).[5] The electrification rate significantly increased in 2004 and subsequent years, in pursuit of the government's objective to electrify all villages by 2007. This may be a tall order, even if it does not mean that all households are to be connected; WAPDA reports that, as of 2004, 81,000 villages were electrified, or 64 percent of 125,083 villages in the country, according to the 1981 census (the number of villages must have increased since then).

Countrywide, about 45 percent of electricity consumption is residential, 30 percent industrial, 11 percent agricultural, 7 percent commercial, and 7 percent others. Geographically, about 13 percent of electricity in 2004 was sold to KESC consumers, 9 percent in the rest of the Sindh province, 60 percent in Punjab, 12 percent in Northwest Frontier Province (NWFP), and 6 percent in Balochistan.

The per capita electricity consumption stands at 378 kWh/year, a low figure compared with a world per capita average of about 2,500 kWh/year, implying the potential for strong upward pressures over time.[6] The electricity intensity of the economy stood at 0.64 kWh/US$ (flat over the past five years), which is a relatively high number, indicating a strong potential for higher efficiency in the use of electricity and lowering the rate of electricity consumption increase relative to GDP growth.

Generation

Pakistan's power generation mix includes a variety of plant technologies and fuels. The system, once dominated by hydro, is now more balanced and includes, in addition to hydro, thermal plants operating on heavy fuel oil (furnace oil), diesel oil, natural gas, coal, and nuclear power (Table 1). Of the total capacity of 19,379 MW (as of June 2005), 12,423 MW (64.1 percent) involve thermal plants of various types (thermal-steam, gas turbine–single cycle, and gas turbine–combined cycle), 6,464 MW is hydropower (33.4 percent) and 462 MW nuclear (2.4 percent). Hydropower production during the FY 2003-2005 period ranged between 22,351 and

Table 1. Capacity Mix (MW) in the Pakistani Power System (as of end of FY 2005)

Hydro	Thermal-WAPDA	Thermal-KESC	Thermal-IPP	Nuclear	Total
6,494	4,835	1,756	5,832	462	19,379
33.5%	24.9%	9.1%	30.1%	2.4%	100.0%

25,671 GWh, with the high end of the range reached in FY 2005. Total thermal generation in FY 2005 was 57,162 GWh, or 66.8 percent of the total generation that year (85,629 GWh). The balance of electricity in FY 2005 was generated by the nuclear plants (2,795 GWh). Electricity generation and consumption in the last five years is shown in Table 2.

Major additions to Pakistan's generation system were made in the 1990s: capacity grew from 10,596 MW in 1993 to 17,399 MW in 2000, mainly on account of IPPs. Since then, the largest addition was WAPDA's 1,450-MW Ghazi Barotha hydropower plant, which came online in 2004. Interestingly, no construction of a major power plant has started during the last several years, in spite of clear signals that the supply-demand balance is tightening. PPIB has invited offers from private investors for a number of hydropower and thermal plants, and WAPDA has an active hydropower investment program, with several plants, of relatively small to medium size, under construction.[7]

There is potential to increase generation capacity by rehabilitating some of the existing plants. The average annual capacity factor for the thermal plants in FY 2005 was 52.5 percent,[8] which is relatively low, although higher than 42.3 percent in FY 2000. KESC thermal plants had the highest average capacity factor in FY 2005 (60.5 percent), followed by WAPDA (52.4 percent) and IPPs (50.2 percent). Clearly, with proper maintenance and operation and fuel available, the thermal plants could produce over 50 percent more energy from the existing units than they did in FY 2005.

The fuel mix used for power generation shows a major shift toward domestic gas, away from liquid fuels (furnace oil and diesel oil). In FY 2000 liquid fuel was dominant, at 55 percent of the total—6,072 mil-

Table 2. Gross Generation by Source for the Last Five Years (GWh)

	FY01	FY02	FY03	FY04	FY05	ACGR*
WAPDA-hydro	17,194	18,941	22,351	26,944	25,671	5.9%
WAPDA-therm	16,835	18,659	19,574	20,972	22,189	3.0%
KESC-therm	7,990	8,709	8,808	9,724	9,304	3.7%
IPP (therm)	24,101	23,805	23,209	21,426	25,669	6.0%
Total Thermal	48,926	51,173	51,591	52,122	57,162	4.4%
KANUPP-nucl	312	492	236	78	322	
CHASNUPP-nucl	1,686	1,798	1,504	1,682	2,473	
Total Nuclear	1,998	2,290	1,740	1,760	2,795	47.6%
Total Generation	68,118	72,404	75,682	80,826	85,628	5.4%

**Annual Compound Growth Rates*

lion tons of oil equivalent (MTOE) out of total 11,032 MTOE—with gas at 43.6 percent. By FY 2005, the share of liquid fuel fell to 24.5 percent, while the share of gas increased to 74.9 percent, even as the total use of fuel increased by 24.6 percent to 13,751 MTOE. The balance of the fuel in both years was coal (1.4 percent in FY 2000 and 0.6 percent in FY 2005). This shift was particularly prominent in FY 2004 and FY 2005, due to a major increase in domestic gas production and the sharp increase in liquid fuel prices; for example, the price of furnace oil for WAPDA plants increased from 10,154 Rs./ton in FY 2002 to 15,797 Rs./ton in FY 2005, a 56 percent increase, while the natural gas prices increased only 17 percent during the same period, from 160.64 Rs./MMcf to 188.3 Rs./MMcf. It is interesting to note that the average thermal efficiency of the plants has been fairly constant over the last five years, holding at about 4.16-4.17 MWh/TOE, or just under 36 percent efficiency. This appears to be on the low side, given a predominant share of natural gas in the fuel mix, which could be used in more efficient combined-cycle units.

Transmission

The transmission system has also been expanding but at a slower pace than the load in recent years, which points to a tightening of the transmission capacity and higher probability of overload and bottlenecks. The transmission system in Pakistan consists of 500-kV and 220-kV networks, with subtransmission voltage levels of 132-kV and 66-kV. The total length of the WAPDA transmission/subtransmission networks[9] in FY 2005 was 46,062 circuit-kilometers (c-km), of which 4,377 c-km were 500-kV lines, 6,403 c-km 220-kV lines, 27,731 c-km 132-kV lines, and 7,551 c-km 66-kV lines. Between 1998 and 2004, the peak load in the WAPDA system grew more than 25 percent (from 8,825 MW to 11,078 MW),[10] while the transmission/subtransmission system expanded only 9.6 percent, with the 500-kV and 220-kV portion expanding only 7 percent. The capacity of the transmission substations during the same period increased 17.8 percent (from 33,673 MVA to 39,663 MVA), faster than the line additions but still below the load growth. The substations capacity increase was concentrated in the 220-kV network, where it grew 38.8 percent, largely in 1999 and 2000.

Distribution

Similarly as for the transmission system, the rate of the expansion of the distribution networks appears to be lower than the load growth. The total length of distribution lines in the WAPDA service area in 2004 stood at 201,391 km at the 11-kV level and at 137,831 at the 440/220-kV level, an increase of 5.6 percent and 7.5 percent, respectively, relative to 2001, which is much lower than the increase in the number of consumers or in consumption—yet another indication of the probable tightening of the system's capacity to accommodate future demand growth without adequate increase in investment.

Regional Integration

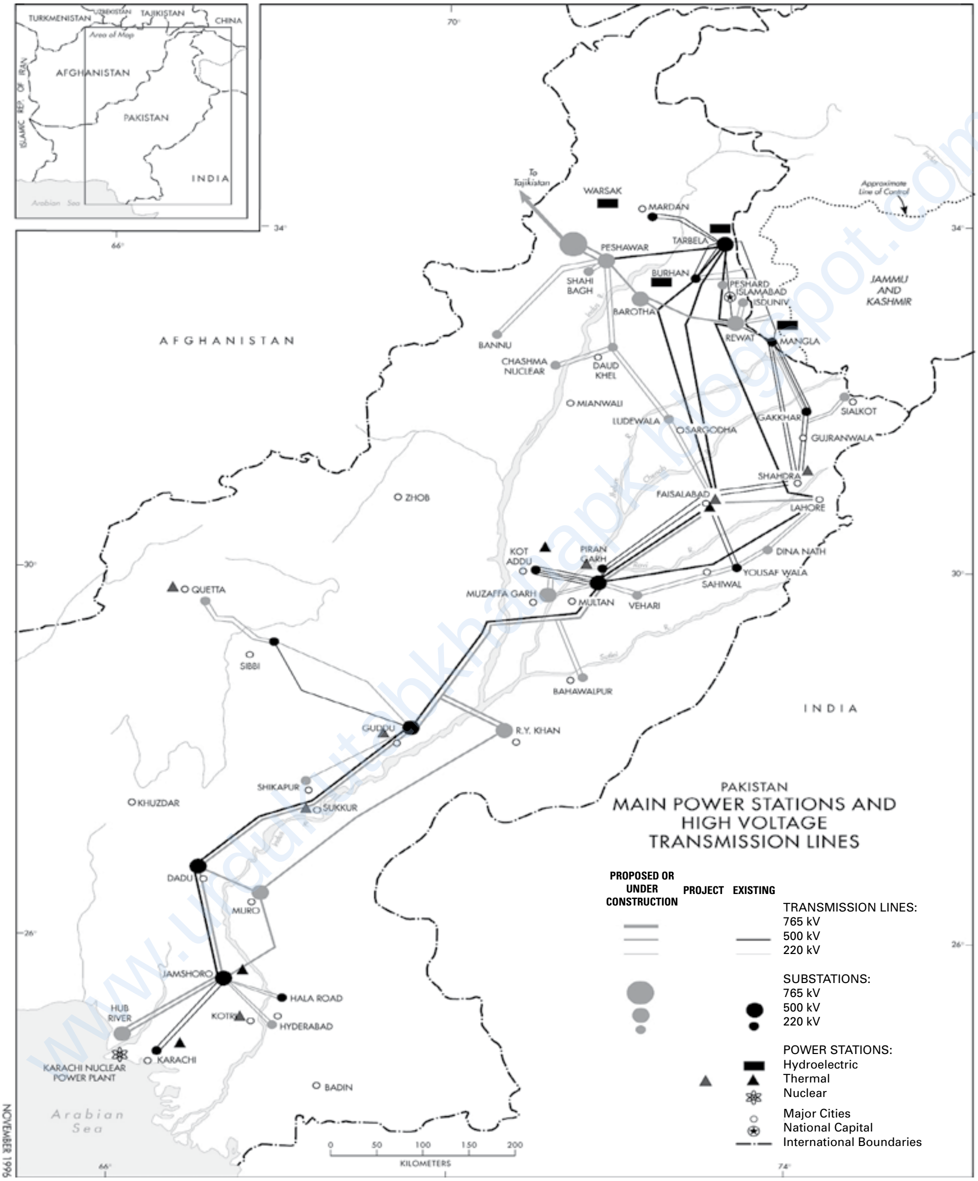
A map of Pakistan's electricity system, showing the major generating stations and the major transmission lines, is given in Figure 2. It is interesting to note that Pakistan's national integrated high-voltage electricity network has no interconnections with neighboring countries. The only interconnections exist with Iran, via a 132-kV and two 20-kV lines, which serve the local cross-border areas in Balochistan and are not

Table 3. Pakistan Electricity Distribution Companies and Numbers of Customers

Distribution Company	Domestic	Com'cial	Industrial	Agri-cultural	Public lighting	Bulk supply	Traction	Total	Percent by region
LESCO	1,858,497	384,899	51,212	35,426	1,220	483	4	2,331,741	
GEPCO	1,651,689	233,979	41,131	32,651	273	126	0	1,959,849	
MEPCO	2,127,448	306,210	29,775	37,986	800	356	4	2,502,579	
FESCO	1,695,277	243,240	32,448	20,766	887	423	0	1,993,041	
IFESCO	1,249,978	227,291	9,590	5,259	1,079	757	0	1,493,954	
Total in Punjab	8,582,889	1,395,619	164,156	132,088	4,259	2,145	8	10,281,164	73.0%
PESCO* (NWFP)	1,910,706	245,997	24,042	28,475	652	846	0	2,210,718	15.7%
HESCO (Sindh)	950,485	220,761	19,669	21,012	764	707	0	1,213,398	8.6%
QESCO (Baluch)	292,998	73,085	2,429	17,254	125	167	0	386,058	2.7%
Grand Total	11,737,078	1,935,462	210,296	198,829	5,800	3,865	8	14,091,338	100.0%

**PESCO in this table includes the newly separated company TESCO.*

Figure 2. Main Power Stations and High Voltage Transmission Lines


TURKMENISTAN
UZBEKISTAN
TAJIKISTAN
CHINA
Area of Map
AFGHANISTAN
ISLAMIC REP. OF IRAN
PAKISTAN
INDIA
Arabian Sea
70°
34°
66°
To Tajikistan
WARSAK
MARDAN
TARBELA
PESHAWAR
SHAHI BAGH
BURHAN
PESHARD
ISLAMABAD
ISDUNIV
BAROTHA
REWAT
MANGLA
Approximate Line of Control
JAMMU AND KASHMIR
AFGHANISTAN
BANNU
CHASHMA NUCLEAR
DAUD KHEL
MIANWALI
LUDEWALA
SARGODHA
GAKKHAR
SIALKOT
GUJRANWALA
SHAHDRA
FAISALABAD
LAHORE
ZHOB
KOT ADDU
PIRAN GARH
DINA NATH
YOUSAF WALA
SAHIWAL
MUZAFFA GARH
MULTAN
VEHARI
30°
QUETTA
SIBBI
BAHAWALPUR
INDIA
GUDDU
R.Y. KHAN
SHIKAPUR
SUKKUR
KHUZDAR
PAKISTAN
MAIN POWER STATIONS AND HIGH VOLTAGE TRANSMISSION LINES
DADU
MURO
26°
JAMSHORO
HALA ROAD
HUB RIVER
KOTRI
HYDERABAD
KARACHI
KARACHI NUCLEAR POWER PLANT
BADIN
Arabian Sea
0 50 100 150 200
KILOMETERS
66°
74°
NOVEMBER 1996
PROPOSED OR UNDER CONSTRUCTION
PROJECT
EXISTING
TRANSMISSION LINES:
765 kV
500 kV
220 kV
SUBSTATIONS:
765 kV
500 kV
220 kV
POWER STATIONS:
Hydroelectric
Thermal
Nuclear
Major Cities
National Capital
International Boundaries

integrated with Pakistan's main transmission network. The same is true for natural gas—there are no gas pipelines crossing Pakistan's borders and all natural gas consumed in the country is indigenous.[11]

TECHNICAL AND FINANCIAL PERFORMANCE OF THE POWER SECTOR

Total losses in the WAPDA system have been maintained within the 22.8–27.5 percent range since the 1990s, with the lowest level in 1990 (22.8 percent) and the peak level in 1999 (27.5 percent). The largest share of the losses is at the low voltage distribution level (11-kV and lower), which fluctuated between 11.5 percent and 18 percent, while the losses in transmission/subtransmission ranged between 7.3 percent and 9.2 percent, with the tendency to be closer to the lower end of the interval during recent years. The auxiliary consumption of WAPDA power plants has been about 2–3 percent. During the last few years, the losses declined slightly, 0.4–0.8 percent per year, and in FY 2005 stood at 24.7 percent, of which 15.3 percent was in distribution, 7.4 percent in transmission/subtransmission, and 2 percent in generation. The overall losses are not higher than—and may even compare favorably with—figures of other utilities in South Asia, but are still about 10 or more percentage points above the norm. Losses in KESC are even higher, consistently exceeding 40 percent since 1998 (44.7 percent in FY 2004).

There is space for improved efficiency in all three segments of the value chain—generation, transmission, and distribution. In generation, there is good potential to achieve better fuel efficiency through rehabilitation and further change in the technology mix, particularly by increasing the share of combined cycle plants running on natural gas. In transmission and subtransmission networks, the emphasis should be on reducing the overloads and bottlenecks to allow more economic dispatch, reduce service outages, improve voltage, and reduce losses.

The largest potential for reducing losses is in distribution, where above-the-norm losses are the highest. There are wide variations in the level of losses across distribution companies and geographic regions (see Table 4). Generally, the companies operating in the Punjab have lower losses, in FY 2005 varying between 9.9 percent (IESCO) and 16 percent

Table 4. Billing Losses in Distribution Companies (FY 2005)

Distribution Company	Energy Input GWh	Energy sold GWh	Losses
LESCO	13,634	11,832	13.20%
GEPCO	5,905	5,279	10.60%
FESCO	7,919	7,122	10.10%
IESCO	6,209	5,596	9.90%
MEPCO	9,363	7,868	16.00%
PESCO	8,021	5,556	30.70%
TESCO	2,776	2,088	24.80%
HESCO	6,120	4,003	34.60%
QESCO	4,121	3,492	15.30%
Total	64,068	52,835	17.50%

(MEPCO). (The average for the province was 12.4 percent.) QESCO, which operates in Balochistan, had 15.3 percent losses, TESCO (in the Federally Administered Tribal Areas) 24 percent, PESCO (in the Northwest Frontier Province) 30.7 percent, and HESCO (in Sindh Province, excluding Karachi) 34.6 percent.

The reported distribution losses are "billing losses," defined as the difference between the electricity that enters the distribution network and the electricity billed to the consumers, therefore combining both technical and commercial losses. While technical losses in Pakistan must also be higher than the "norm" due to overload and other adverse conditions, the reported billing losses are above those that can be explained by technical losses alone. The "non-technical" losses—electricity not billed as a result of illegal connections, improper recordings, meter tampering, etc.—are present in all service areas, but are especially high in the service areas of HESCO, PESCO, and TESCO, and also in MEPCO and QESCO. Reducing both technical and non-technical losses requires investment, as well as managerial, administrative, and law enforcement measures, such as better maintenance planning, network management and load balancing, customer management, internal controls, theft detection, and prosecution.

Two other major potential sources of financial distress are poor collection of bills and below-cost tariffs. While there is still space for improvement, WAPDA DISCOs have increased collections, which in FY 2005 stood at 94 percent. However, end user tariffs continue to lag behind the cost of service.

The current WAPDA tariffs were set in November 2003. The electricity production costs have increased significantly since then. Between FY 2003 and FY 2005, prices of furnace oil and natural gas—the two most heavily used fuels in WAPDA plants—increased by 29 percent and 12 percent, respectively, and WAPDA's total fuel bill by 18 percent, with further increases after that. Already in FY 2005, the average cost of delivery was 4.2 Rs./kWh, higher than the average tariff of 3.96 Rs./kWh,[12] charged to consumers. WAPDA's profit and loss account, showing slight surpluses in FY 2004 and FY 2005 (Rs. 0.7 billion and 2.4 billion, against total revenues of Rs. 223.5 billion and 235.5 billion, respectively), is likely to show a sizable deficit in FY 2006, possibly close to 20 percent of the revenues. The situation in KESC is even more precarious: in FY 2005, KESC's financial losses amounted to Rs. 11.9 billion before subsidies, against total revenues of Rs. 39.8 billion.

In addition to being below the cost of supply, the tariffs have a significant cross-subsidy element between the consumer categories. The applicable tariffs for residential consumers, at the beginning of FY 2005, ranged from 2.41 Rs./kWh for the first 100 kWh per month, to 3.31 Rs./kWh for the next 200 kWh, to 5.59 Rs./kWh for the next 700 kWh, to 6.74 Rs./kWh above 1000 kWh.[13] The industrial and bulk supply tariffs, which—if all the tariffs were cost reflective—should be significantly lower than the residential, were generally around 5 Rs./kWh or higher.

Cross-subsidies exist between geographic regions as well, since the tariffs are uniform across the country, while the cost of supply differs—in some cases significantly—for a variety of reasons: a more adverse consumer mix, a more spread-out network and lower load density, higher incidents of theft, etc. To make matters more complicated, the high-cost areas tend to have poorer service (more frequent outages, longer restoration time, substandard voltage, etc.) and lower income, making the imposition of geographically differentiated, cost reflective tariffs more difficult.

The government has supported the sector (and electricity consumers) with significant subsidies and other financial injections (tax waivers, cash subsidies, debt-for-equity swaps, investment loans and grants, cash subsidies, etc.) to cover the financial losses caused by the billing and collection losses, below cost tariffs, and other inefficiencies. Some World Bank estimates indicate that explicit and implicit subsidies to the power sector amounted to about 1–1.5 percent of GDP per year (i.e., about US$3 billion over the past two years). The deficit is a major drain on public finances and exposes both the budget and the sector to increasing risks, especially if costs continue to rise and/or the government budget comes under pressure.

THE POWER SECTOR REFORM PROGRAM

Reform Design

The issues facing the sector, described in the previous sections, are not new and have been present, in various degrees and emphasis, at least since the 1980s. (For example, in 1984, WAPDA reported total losses in its system of 29.3 percent.) As mentioned in the introduction to this essay, in order to address these problems, the government embarked on sector reform starting in the early 1990s. Although it has taken much longer to implement than initially envisaged, the basic reform design introduced at that time is still being followed, with few modifications. That design included the following principal elements:

- *Structural elements:* (a) unbundling of WAPDA into separate generation, transmission and dispatch, and distribution companies, with a number of companies in the generation and distribution segments; and (b) establishing appropriate electricity trading and financial settlement arrangements, first based on a regulated single-buyer model, followed by progressive introduction of competition and more liberalized generation and supply markets;
- *Institutional elements:* separation of the policy, regulatory, and ownership functions; and
- *Ownership and investment elements:* privatization of the existing distribution and generation companies and expansion of the sector through investment in existing and new companies.

The structural part of the reform focused on WAPDA as the dominant utility, whereas the strategy for KESC was simply to privatize it as a vertically integrated utility.

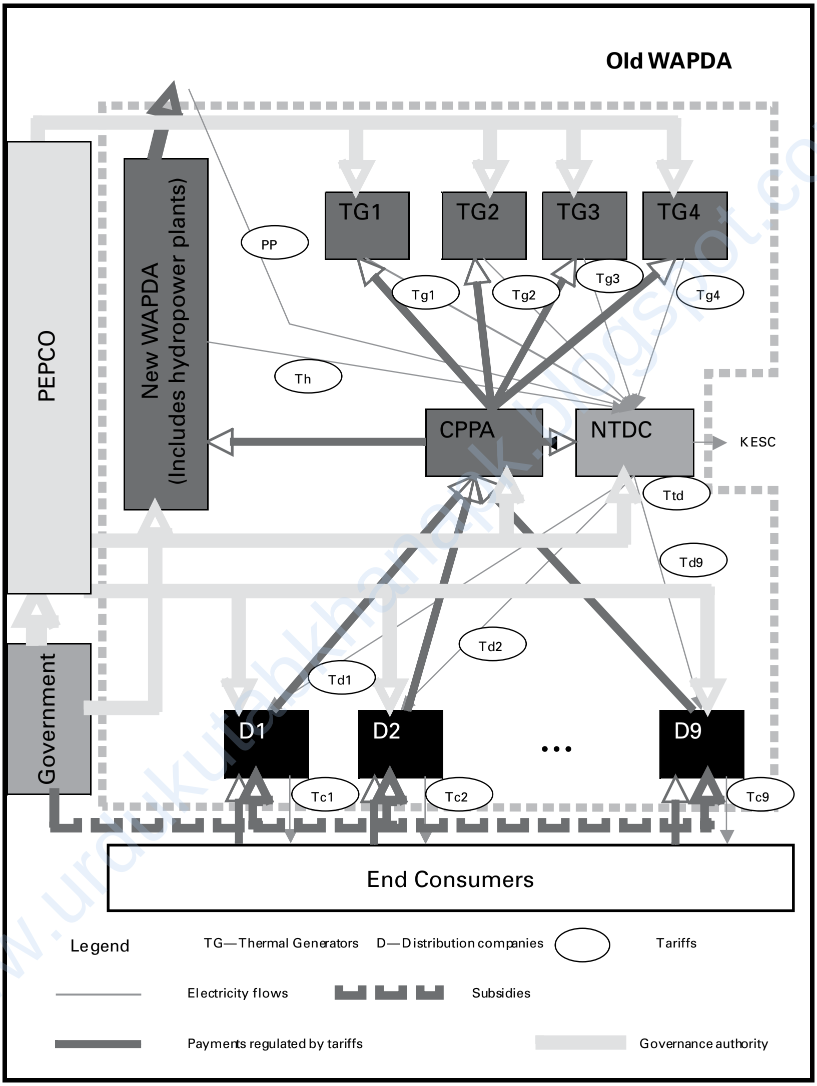
Each of the reform elements aims to contribute to the reform objectives. The *structural* reform should lead to improved transparency in trading, dispatch, and financial management, enabling better identification of inefficiencies and their location and causes. The *institutional* reform should improve transparency, efficiency and quality of regulation, policy development and implementation, and sectoral and corporate governance, through appropriate division of responsibilities among the institutions and strengthening their capacity. *Privatization* should bring in investment capital and managerial know-how, enhance commercial performance and customer services, and reduce the burden of the sector on public financing.

Figure 3 shows the expected structure of the sector after completion of the first stage of the reform program, which is to achieve the following outcomes:

- *Structural reform:*
  - The unbundling of WAPDA into several thermal generation companies (GENCOs), denoted as TG1 through TG4 in Figure 3 (hydropower assets are to stay with WAPDA), one (national) transmission and dispatch company (NTDC), and nine distribution companies (DISCOs), denoted as D1 through D9. The companies are to be legally registered under corporate law and have their tariffs determined by the National Electric Power Regulatory Authority (NEPRA).
  - Trading arrangements based on a single-buyer model with regulated prices (competition in generation and supply and transition toward a model with multiple sellers and buyers are to be introduced in subsequent reform stages). The trading arrangements would involve the Central Power Purchasing Agency (CPPA), which would buy electricity from all generation companies and sell it to the DISCOs and KESC.[14]

- *Institutional reform:*
  - Regulation: establishment of an independent regulatory agency

Figure 3. Power Sector Reform—first phase (single-buyer trading model


Old WAPDA
PEPCO
New WAPDA (Includes hydropower plants)
TG1
TG2
TG3
TG4
PP
Tg1
Tg2
Tg3
Tg4
Th
CPPA
NTDC
KESC
Ttd
Td9
Td2
Td1
D1
D2
...
D9
Tc1
Tc2
Tc9
Government
End Consumers
Legend
TG—Thermal Generators
D—Distribution companies
Tariffs
Electricity flows
Subsidies
Payments regulated by tariffs
Governance authority

to set tariffs, issue licenses and enforce their provisions, establish and enforce technical and safety operating standards, and approve investment and power acquisition programs of the utility companies.

- o Policy development and implementation: increased capacity of the governmental agencies, especially the Ministry of Water and Power, to develop and implement power sector policies.
- o Corporate governance and management: stronger government role and capacity to exercise ownership responsibilities over state-owned companies in the sector, with improved practices in corporate governance and management, including competent and businesslike boards of directors, appointed through a transparent and merit-based process. For an interim period, a separate governmental agency—Pakistan Electric Power Company (PEPCO)—is to act both as a holding agency over the state-owned WAPDA-successor companies and as an agency managing WAPDA restructuring.

- *Ownership and investment:* progressive privatization of the distribution and generation companies in parallel with efforts to strengthen the performance of the sector through investment in existing and new assets.

Reform Implementation

The initial reform implementation schedule called for unbundling WAPDA and establishing the wholesale power market by 1996. However, events followed a different path. Under the pressure of electricity shortages in the 1980s and early 1990s, priority was given to increasing generation capacity through private investment before undertaking sector restructuring. The first power policy, oriented toward attracting private investment, preceded the sector reform plan and was adopted in 1985, but implementation was slow. As part of the reform program, the government issued a new *Private Power Policy* in 1994 with more attractive and standardized terms for IPPs. To facilitate and streamline the process, the government also created the Private Power and Infrastructure Board (PPIB), as a “one-stop window” for private investors. Under this policy, IPPs were to sell electricity to WAPDA under long-term power purchase agreements (PPAs), guaranteed by the government and administered by the WAPDA Power Privatization Organization (WPPO). The enthusiastic response of the private sector resulted in a significant addition of new generation capacity and, as mentioned in the second section of this essay, 16 IPPs are operating in Pakistan today.[15] The 1992 policy has been updated twice since that time, first in 1998 and then in 2002, broadening the applicability of the policy.

In addition to the green-field private investments, progress has been made in privatization of the existing power companies. The most notable event was the sale of 73 percent of KESC in November 2005 to a consortium of private investors.[16] Earlier, in 1996, 36 percent of the shares of the large Kot Addu thermal plant (1466 MW) were sold to the private sector; the sale of an additional 18 percent through a public offering in February 2005 resulted in private investors owning the majority of the shares of the company (54 percent; see note 2).

Because of the urgent need to bring in new generation plants, unbundling of WAPDA was delayed until 1998, when WAPDA's Power Wing was formally restructured and its successor companies legally registered. First, three thermal generation, eight distribution, and one transmission and dispatch company were established, with WAPDA retaining hydropower plants. Later, another thermal generation and one more distribution company were created (see section two). The WAPDA Act was amended in 1999 to reflect the restructuring.

On the regulatory front, the National Electric Power Regulatory Authority (NEPRA) was first established in January 1995 through a presidential ordinance, which was repeatedly extended up to 1997, when the government enacted the Regulation of Generation, Transmission and Distribution of Electric Power Act XL of 1997 (the "NEPRA Act") and the Authority was formally established on January 13, 1998. For the sake of interaction with federal and provincial governments, NEPRA was originally attached to the Ministry of Water and Power, but subsequently was required to route its correspondence with the government through the Ministry of Law and Justice. Finally, in June 2000, the cabinet placed NEPRA within the Cabinet Division.

PEPCO was established (incorporated) in late 1998 and became effective in 1999.

Although the government has no administrative control over NEPRA, it continues to play a key role in tariff regulation. Namely, a tariff determination by NEPRA becomes legally binding only after being "notified" by the government, which severely limits NEPRA's institutional independence.

A key requirement for the new structure to work as intended is that *each* company in the power system has its own tariff determined by NEPRA (except for competitively procured generation with competition based on electricity price offers).[17] As of mid-2006, NEPRA had determined—and the government "notified"—power sales tariffs for thermal generation companies (Tg1 through Tg4 in Figure 3), hydropower tariffs (Th), the tariff that NTDC charges for its services (Ttd), and the mechanism for the calculation of power purchase tariffs for distribution companies (Td1 through Td9 in Figure 3).

End-user tariffs for individual DISCOs (Tc1 through Tc9), however, have not been set yet, although the issue has been under consideration since 2004. Therefore, the sector continues to operate under the tariff notification of November 21, 2003, which set the end-user tariffs as the rates "…in respect of the electric power services provided by WAPDA…"[18] This means that the formal ownership and control of the revenues collected by DISCOs belong to WAPDA. While the payments to NTDC and to the power generation companies are governed by their tariffs, the allocation of the remaining revenues among distribution companies is internal to the WAPDA/DISCOs group. An important feature of the process is that it allows internal shifting of the funds between DISCOs (and, thus, the provinces)—i.e., from those whose overall costs are below notified end-user tariffs (and, hence, have a cash surplus) to those whose costs are above the tariffs (and have a cash deficit).

Figure 4 shows the current status of the sector reform (as of mid-2006). A comparison with Figure 3 (the target restructuring model) shows that some of the important features of sector reform are yet to be completed. The key differences between the target model and the current structure are the following:

- WAPDA keeps some important functions which should belong to the single-buyer agent (management of the financial flows) and to the regulatory agency (distribution of the sector revenues among DISCOs).
- Since the chairman of WAPDA also holds the position of chairman of PEPCO, it is WAPDA that de facto plays the role of the holding

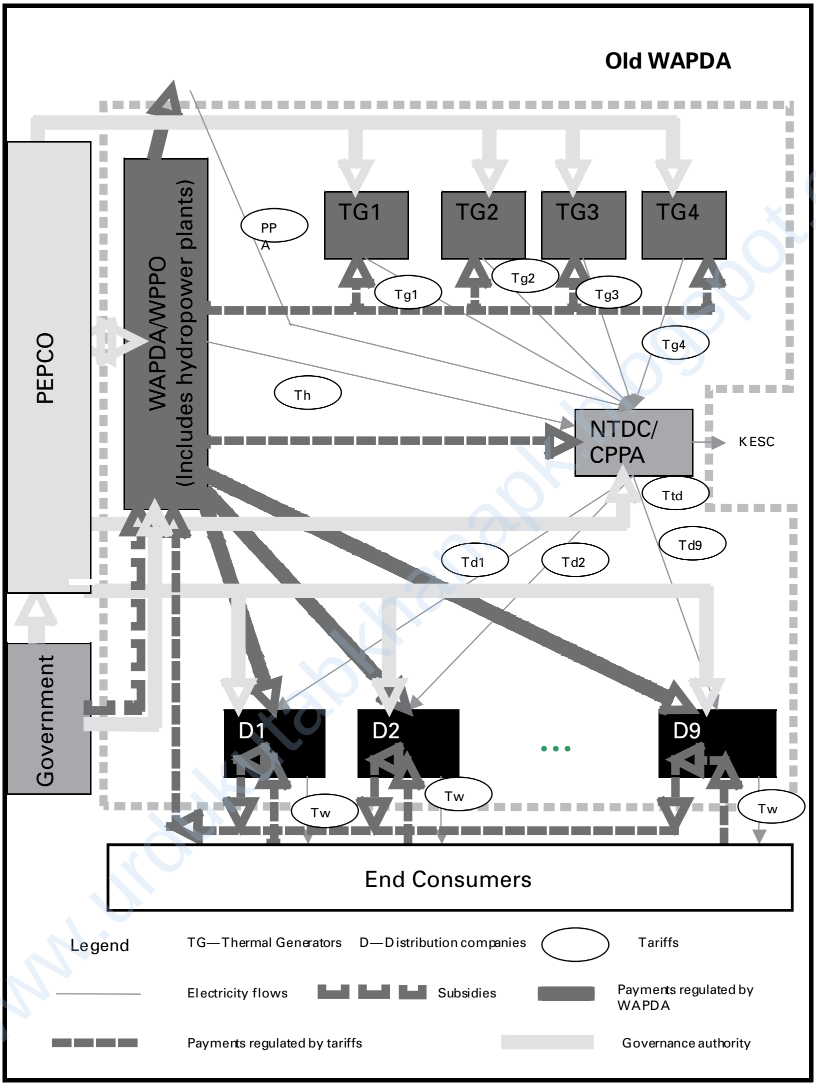
company and exercises ownership control over all WAPDA successor entities (appointment of the boards of directors and, in turn, of senior management), and thus, in large measure, controls its own restructuring.

The prevailing situation creates a number of challenges, especially in the distribution segment of the sector:

- DISCOs are not financially autonomous and, thus, may not feel fully empowered and accountable for their performance, contrary to the objectives and the spirit of the sector reform.
- DISCOs' incentives, attention, and time are diverted from the effort to increase efficiency and collection of revenues to the collective bargaining over the sharing of sector revenues.
- It is difficult for a DISCO to develop a credible corporate strategy and investment plan, because of the funding uncertainties. Similarly, DISCOs cannot establish their own financial track records and credit ratings, a situation that hampers their borrowing ability and investment financing.
- Privatization of distribution companies is also delayed, as it is practically impossible to appraise and evaluate them individually without knowing what the tariffs are.[19]
- At the sectoral level, it is difficult to establish a fully transparent wholesale market and rule-based financial management system, and thus more clearly—and more publicly—expose the sources of inefficiencies, which would lead to better-targeted interventions through regulatory, governance, and managerial interventions and instruments, as well as through increased public scrutiny of the performance of individual distribution companies.

A similar problem—lack of financial and managerial autonomy—exists in generation and transmission. Although generation and transmission tariffs are set by the regulator, since there are no codified, transparent rules for management of payments, WAPDA controls the cash flows and, thus, the revenues of the generation companies and NTDC as well. Therefore, the power system, in practice, continues to function largely as before—i.e., as a centrally controlled, vertically integrated monopoly.

Figure 4. Power Sector Reform—current status


Old WAPDA
PEPCO
WAPDA/WPPO
(Includes hydropower plants)
PPA
TG1
TG2
TG3
TG4
Tg1
Tg2
Tg3
Tg4
Th
NTDC/
CPPA
KESC
Ttd
Td1
Td2
Td9
Government
D1
D2
...
D9
Tw
Tw
Tw
End Consumers
Legend
TG—Thermal Generators
D—Distribution companies
Tariffs
Electricity flows
Subsidies
Payments regulated by WAPDA
Payments regulated by tariffs
Governance authority

SUMMARY ASSESSMENT AND THE WAY AHEAD

Electricity consumption has already increased to a point where the system production reserves have shrunk to a precariously low level. As the previous sections describe, investment has been lagging behind load growth, progressively increasing the risk of deteriorating service and supply disruptions. Efficiency improvements are modest, particularly in the areas where efficiency is lowest. The rising costs are outstripping sector revenues at an increasing rate. The sector is a major and growing drain on the government budget, while—at the same time—it continues to subsidize consumers through unbilled consumption, uncollected bills, and below-cost tariffs. Managerial and technical talent within the state-owned segment of the sector is still constrained by the lack of full empowerment, stronger incentives and full accountability. The power system continues to operate in isolation from neighboring countries—as does its natural gas network—at possibly significant opportunity costs. Structurally, the sector is at a crossroads and needs to decide which way it wants to go: although unbundled in the technical legal sense, the system continues to operate as vertically integrated. Staying suspended in this half-restructured state with conflicting responsibilities for operational and financial performance carries significant risks.

The following are some of the key measures whose implementation would lead to decisive progress in completing the reform program and to a better positioning of the sector to respond to the challenges it faces:

- ***Power sector reform:***
    - o *DISCO tariffs:* Setting distribution margins for individual distribution companies is a critical step to completing the sector reform as designed. This would increase financial autonomy of the sector entities and transparency in the sectoral financial flows, empower DISCOs to control their performance for which they would be held accountable, better tailor corporate strategies to local conditions, enhance public scrutiny, induce more "competition by comparison" among DISCOs, and facilitate privatization.
    - o *Subsidies:* As part of the tariff-setting process, the government would decide on the level of subsidies that it can afford and that it is prepared to grant to different consumer categories and/or to some

DISCOs/geographic regions, and would explicitly accept responsibility for timely disbursement of subsidies.

- *Consumer tariffs and sector revenues:* It is important that the combined end-user tariffs and subsidies cover the supply costs, with some imbedded features to encourage efficiency improvements (e.g., through multi-year tariffs for DISCOs with declining allowances for losses). The existing tariff design deserves to be revisited to ensure better cost-reflectivity, reduce cross-subsidies, simplify tariff structure, and better target assistance to the poor.
- *Wholesale trading and financial management:* The transparency in the financial flows and predictability in the financial position of each company in the sector would be greatly improved by instituting clear and enforceable rules for managing payments (which could be performed by commercial banks), with defined priorities as to the claims on sector revenues and a mechanism for managing revenue shortfall, should it appear.[20] A fully functional, autonomous—or, if within NTDC, a ring-fenced—Central Power Purchasing Agency would further enhance this transparency and reduce the potential for conflict of interest in managing the payments. This would also set the stage for subsequent improvements in electricity market design (more competitive multi-seller/multi-buyer trading arrangements, transitioning away from the single-buyer model).
- *Regulation:* There is little disagreement among the stakeholders that the regulatory framework needs further development. Some of the areas that need to be addressed include: an effective mechanism to resolve potential disagreements between NEPRA and the government; disputes between NEPRA and the licensees that it regulates; monitoring of the performance of the licensees and the market; and so on.
- *Governance:* Governance arrangements where the ownership functions are exercised by the agencies that bear financial consequences of the performance of the companies—good or bad—would strengthen the incentives for performance-oriented management. The governance would be further enhanced if the members of the boards of directors were selected through a transparent, merit-based process aimed at creating competent, businesslike boards, and if appropriate checks and balances in the governance system were introduced.

  - *Privatization:* The government strategy to continue privatization of generation and distribution companies, aimed at selecting owners/operators with adequate resources and competence through a transparent and competitive process, is laudable. The government may choose to facilitate privatization with additional support—for example, by formally guaranteeing government policy and financial undertakings (such as regulatory framework, consumer subsidies, etc.)—to reduce the risk to the private sector and, thus, the cost to investors and, in turn, to consumers.

- ***Power sector investment:*** Pakistan's power sector needs to step up investments in all segments—generation, transmission, and distribution—to improve efficiency of the existing system and to expand the sector to meet new demand. The reform measures listed above would create a more transparent and predictable environment for the companies operating in the sector (public and private alike) and, in conjunction with the government's established Private Power Policy, lead to better identification and prioritization of investment projects, faster mobilization of investment financing (from private investors, commercial lenders, international financing organizations, etc.), lower investment cost, and more effective implementation of investment projects.

- ***Regional integration:*** As mentioned in the third section of this essay, Pakistan's integrated high-voltage national power grid lacks connections to neighboring systems, possibly at significant opportunity costs. In addition to the potential benefits from wholesale electricity imports (such as, possibly, from Central Asia), there are other important interconnection benefits: short-term support in emergencies and major outages, sharing of operating reserves, voltage support, etc. Similarly, Pakistan could benefit from imports of natural gas, as some of the world's largest producers are in Pakistan's neighborhood. Imports of electricity (and gas) through regional integration will require cooperation with other countries in joint investment programs, which would eventually lead to the creation of integrated regional electricity (and gas) networks.[21]

Most, if not all, of the above measures *are* part of the government's program in the sector. The issue, therefore, is not so much of the program design as of its implementation. Time is of the essence and continued hesitation and delays in completing the reform carry serious risks to its ultimate success and to the ability of the power sector to invest, improve technical and commercial performance, and adequately support Pakistan's economic and social development.

NOTES

1. WAPDA, as its name indicates, has two principal wings: water and power. For simplicity, WAPDA will be used as a synonym for its Power Wing, since this paper is concerned with the power sector.

2. WAPDA also owns 46 percent of shares in the 1600-MW Kot Addu power company (KAPCO), with the remaining shares in KAPCO held by National Power of the U.K. (36 percent) and the general public (18 percent). KAPCO is managed by National Power (now International Power), which is acting through its Pakistani subsidiary National Power (Kot Addu) Limited (NPKAL).

3. *Pakistan Energy Yearbook 2005*, Hydrocarbon Development Institute of Pakistan, Islamabad, December 2005; and WAPDA: Presentation to South Asia-Central Asia Electricity Trade Conference, Islamabad, May 8-9, 2006.

4. *Projects Profile: Seven Raw Hydel Sites*, Private Power and Infrastructure Board, Ministry of Water and Power, Government of Pakistan (February 2005).

5. The official electrification figures underestimate the number of electrified households, as households are also connected through illegal lines.

6. The per capita annual energy consumption of about 0.22 TOE/year is very low compared with a world average of about 2 tons of oil equivalent, but shows an increasing trend (10 percent increase from FY 2004 to FY 2005).

7. There are currently nine hydropower projects under implementation in the public sector (by WAPDA), ranging from 13 MW to 130 MW, for a total capacity of 679 MW and completion between 2007 and 2010.

8. Annual capacity factor of a plant is the ratio between the average capacity (in MW) used in a given year and the plant's full capacity (in MW). Capacity factor for hydropower plants is constrained by the amount of available water. Capacity factor of thermal plants is usually not limited by the availability of fuel, but rather by its technical availability and dispatch priority (merit order). Capacity factor measures the utilization of a plant. It is common to have annual capacity factors for coal plants above 70 percent, and for combined cycle gas turbines (which are usually very economic and require shorter maintenance outages), as high as 90-95 percent.

9. The WAPDA transmission system represents the vast bulk of the country's transmission network, as the remaining high-voltage system, belonging to KESC, is much smaller in size, since KESC is confined to the Karachi area.

10. *Power System Statistics*, Twenty Ninth Issue, Water and Power Development Authority, Planning Department Power Wing, February 2005.

11. In FY 2005, Pakistan consumed 55.5 MTOE of primary energy, of which 29.4 percent was oil, 0.4 percent liquefied petroleum gas (LPG), 50.3 percent natural gas, 7.6 percent coal, and 12.2 percent hydropower and nuclear energy. Pakistan produced about 3.2 MTOE of crude oil and imported between 8.3 and 8.8 MTOE. Almost all crude was refined in domestic refineries, producing about 11 MTOE of oil products, which Pakistan also imported in the amount of about 5.7 MTOE. Of the total supply of about 16.7 MTOE of oil products, 15.7 MTOE was consumed in the country and 1 MTOE exported. This means that more than 80 percent of petroleum products consumed in the country is either directly imported or produced in domestic refineries from imported crude. About 50 percent of coal consumed in FY 2005 was imported, mainly for use in the steel and cement industries.

12. World Bank estimates.

13. The reported tariff levels are net of tax. Generally, electricity is subject to the sales tax, but the government has been forgoing the tax as a subsidy to residential consumers.

14. The power purchases are to be based on contracts between CPPA and generating companies. Purchases from existing IPPs could go through WAPDA, since the existing IPPs had their power purchase agreements (PPAs) signed with WAPDA and administered by the WAPDA Power Privatization Organization (WPPO). KESC has significantly higher demand than its own generation plants can cover and has been buying electricity from WAPDA to cover the deficit. This situation is expected to prevail for the foreseeable future, but if and when KESC increases its generation capacity sufficiently, the trade between KESC and WAPDA-successor entities could presumably go in either direction.

15. The process has not been problem-free though, as the government and the investors went through a difficult period of renegotiating some PPAs, between 1998 and 2000. A World Bank paper, "Lessons from the Independent Private Power Experience in Pakistan" by Julia M. Fraser (Energy and Mining Sector Board Discussion Paper, Paper No. 14, World Bank Group, May 2005) describes the experience and the lessons learned in more detail.

16. The consortium included KESC Power Limited, Hassan Associates (Private) Limited and Premier Mercantile Services (Private) Limited, holding 71.5 percent, 1.00 percent and 0.5 percent shares, respectively. The remaining shares are held by the Pakistani government (25.65 percent) and others (1.35 percent). The new management has employed Siemens Pakistan Engineering Limited as the operations and maintenance (O&M) contractor for KESC.

17. The tariffs for the existing IPPs remain to be governed by the PPAs nego-

tiated at the time of their financial closure.

18. In this notification, the word "WAPDA" appears to imply the entire supply chain served by WAPDA and WAPDA-successor entities, from generation to transmission and dispatch to distribution.

19. Two distribution companies—Faisalabad Electric Supply Company and Peshawar Electric Supply Company—have been slated for privatization, but progress has been held up by the fact that they have no company-specific tariffs.

20. The structural deficit—e.g., non-payment for electricity consumed in Federally Administered Tribal Areas (FATA)—would need to be covered either through a mark-up in tariffs for other consumers and/or from the federal budget.

21. Such an initiative is under way. In May 2006, Pakistan, Afghanistan, Tajikistan and the Kyrgyz Republic created a joint expert-level group, supported by a number of international financing institutions and bilateral donors, to investigate the merits for electricity exports from Tajikistan and the Kyrgyz Republic to Afghanistan and Pakistan.

PROMOTING PRIVATE SECTOR PARTICIPATION IN OIL AND GAS PROJECTS—A FINANCING PERSPECTIVE

SANJEEV MINOCHA

Few industries have seen such rapid change in recent years as the oil and gas and mining sectors. While natural resource prices have strengthened revenues and created new opportunities, there have also been perceptions of increased business, economic, political, and social risks, in turn influencing new emerging frameworks for participants as they consider and refine their strategies.

Creating an effective partnership among the public and private sectors in developing a vibrant domestic oil and gas sector requires an appreciation of the valuable role the private sector can play, and of the critical factors that can simultaneously foster commercial success and a sustainable development impact. The right enabling conditions by governments and appropriate initiatives by oil and gas companies can then ensure they are effective participants in an era of increasing convergence of sustainable business with development.

RECOGNIZING THE ROLE OF THE PRIVATE SECTOR

The fundamental role that private participation can play in accelerating the pace of development of a country's oil and gas sector has not changed. The private sector's ability to mobilize capital and to share risk

---

Sanjeev Minocha is a senior investment officer in the Oil and Gas division of the International Finance Corporation. In this capacity, he has led oil and gas transactions in Asia, Latin America, the Middle East, and North Africa. Previously, he worked in the project finance group of ICICI, Ltd, an NYSE-listed Indian bank. He has over 18 years of experience in development banking, focusing on comprehensive investment appraisals, financial structuring, and negotiations for project loans and equity investments. The views expressed in this essay are his own.

forms the primary basis for this partnership. Countries have routinely passed on exploration risks to investors through awarding exploration acreage in periodic bidding rounds. Successful discoveries bring forth development capital, with the government assured of its share of revenues from production via royalties and taxes.

The inherent risk associated with oil and gas exploration and development can be fairly high, but successful upstream projects can generate healthy economic rates of return. While revenue sharing structures vary, it is not unusual to see a 50–60 percent share of the net value from successful oil and gas developments accruing to the government. From the perspective of the state, strong economic benefits can therefore be leveraged with little or no provision of capital, with investors relying on their own share of discovered and developed resources to service their risk capital.

Additionally, getting products to market and creating better access to energy for ultimate consumers require large investments in oil and gas infrastructure—such as in transmission, distribution and storage, and in other downstream capacity. This is another area where private capital can play a useful role.

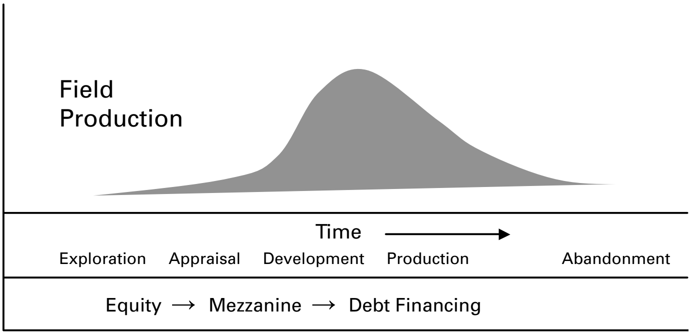
Complementing capital are also the widely acknowledged benefits the private sector brings in the form of new technologies, operational efficiencies, and in helping expand local skills.

At another level, wider participation tends to create depth in the domestic oil and gas sector that can help match investors to the right opportunities that suit them. While national oil and gas companies and the oil and gas majors may engage in large developments and infrastructure projects, smaller local or foreign independent companies can come in to fill in the gaps, working on exploration prospects or developing reserves that are too small to attract the larger players. At the same time, a growing critical mass of investments itself fosters growth of a dynamic support service subsector offering increased efficiencies.

THE PRIVATE SECTOR PERSPECTIVE

A stable and enabling external environment, adequate access to capital, and mitigation of inherent risks are critical factors for successful private sector projects.

Typical Life Cycle of an Upstream Oil and Gas Project



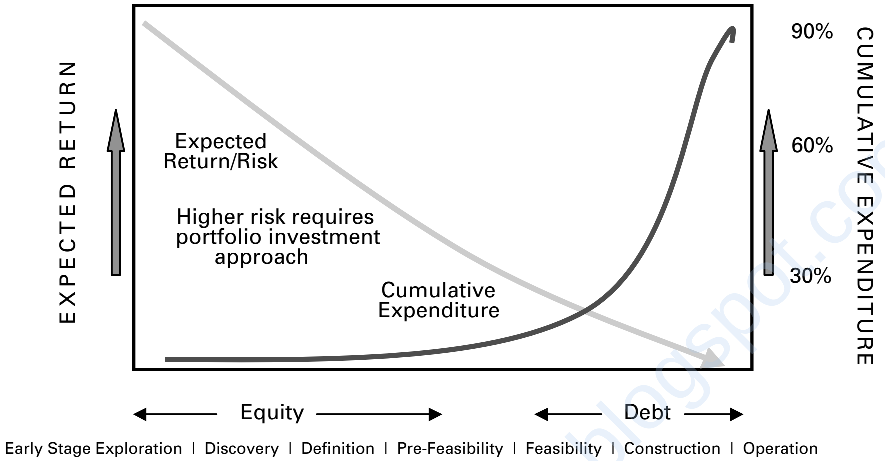
Significant hydrocarbon reserve risks, as well as technical and price risks, are customary for upstream oil and gas projects. The high risk threshold makes a compelling case for the right incentives and stable fiscal regimes that can assure fair risk/reward for investors.

The oil and gas sector involves strong interface with government and regulatory agencies. Timely regulatory support and adherence to contract provisions are critical to sustain investments by oil and gas companies. Many countries have worked hard to devise policies and concession rules that are geared to attract investments. This must also flow through smoothly to implementation agencies, where relatively weak capacity might still hinder projects in realizing the contract rights assured to them.

Another challenge posed to upstream projects arises from the typical life cycle of an oil and gas operation, as it progresses from exploration to appraisal to development and production and finally to abandonment. This life cycle makes for a changing risk profile, of progressively increasing capital needs to full development, and the need to recover investment capital before field reserves inevitably decline to the point of abandonment. (These concepts are illustrated in the accompanying charts.) Projects must have access to financing that is well matched to each stage of the project in its life cycle.

With no reserves to back investments yet, exploration investments are typically funded in equity or in reinvested cash flow from other producing properties. For smaller or stand-alone operations, accessing private equity is an option particularly where exploration may have progressed

The Risk/Return and Investment Tradeoff



Note: lighter shade tracks expected return/risk; darker shade tracks cumulative expenditure.

to some reasonable chance of success. Junior companies also routinely use farm-outs to other industry players to contain investment risk or to diversify risk among multiple exploration properties.

The project's progress from exploration through to appraisal and development requires increasing capital that can be met by mezzanine financings (such as convertible or income participating debt) or with debt financing on the strength of discovered oil or gas reserves. Debt financings—typically project finance or revolving credit facilities—require adequate underlying security. In natural resource sectors, this is widely achieved through providing assignments of concession rights (that become effective only in enforcement circumstances), as well as through pledging revenues from produced hydrocarbons or minerals. Regulators in most developing markets have, at least in principle, recognized the concession holders' needs to create such security assignments in favor of creditors. However, a working-level understanding is often lacking, and obtaining timely approval for such arrangements can often become a nightmare for projects.

Two important financing trends for oil and gas operations in relatively more developed industry environments, or around leading financial centers, deserve special mention. These are often absent as an option in developing country environments.

First, there is now increasing access available to junior oil and gas companies—at late-stage exploration, appraisal, and predevelopment stages—to be able to make initial public offers (IPOs) and to list their shares on international stock exchanges. Indeed, the London Stock Exchange's AIM market (Alternative Investment Market, a global market for smaller, growing companies) and the Toronto Stock Exchange (TSX) have attracted significant listings in recent years from this sector, in turn expanding access for projects to public capital markets. Oil and gas companies raised nearly 10.5 billion Canadian dollars in 2005 alone on the TSX and the TSX Venture Exchange (which provides access to capital for companies in early stages of growth), and at the end of June 2006, there was a total of 428 oil and gas companies listed on these markets. Similarly, nearly one-fifth of the total market capitalization of companies listed on AIM in mid-2006 was accounted for by oil and gas companies. In contrast, the underlying risk/reward equation for oil and gas companies is not easily understood in many developing country equity markets. Such markets may not be exposed to multiple companies with varying risk profiles in the segment. Oil and gas companies may be valued by classic measures of current or prospective cash flow and earnings, with less attention to proved and probable reserves, or the diversity and attractiveness of their exploration potential. For local companies in many developing countries, this may pose a strong constraint—with their options tending to overseas or dual listings.

Second, international companies have relatively easier access to reserve-based lending or revolving credit facilities customary in the sector. These facilities cater efficiently to varying investment needs, or tie in to the fluctuating values of underlying assets, that are typical of upstream oil and gas operations. Lenders in many developing country markets are not accustomed to such products. And in some countries, regulators may not allow such overseas financing on rigid exchange control considerations. In such cases, this could mean limited debt financing flexibility for investors, and often higher financial risks for the project and lenders where term loan financing may not be optimal.

Limited access to local industry skills or service providers is another limitation faced by many new entrants in developing countries. It is not unusual to find a junior oil and gas company in Houston or in Calgary carrying a core staff of 8 to 10 persons. Even for larger independent firms, services may be readily contracted on a needs basis via a network of commercial or technical service providers and a diverse pool of oil services companies. Such access is nearly always absent in countries that have had a traditional predominance of national oil companies and have only recently opened up the sector to private participation. Limited access to a pool of private talent and specialized services manifests in poor flexibility and high overhead costs for new entrants. Suitable incentives and strategies that can bring depth to the domestic oil and gas sector are essential.

THE EMERGENCE OF SUSTAINABILITY AS A KEY FACTOR IN NATURAL RESOURCE DEVELOPMENT

Concerns about sustainability of project activities from the environmental, social, and economic perspectives now take center stage, with implications for all key stakeholders. These aspects now effectively define a project's license to operate—emphasizing the ability to sustain continued operation and to exist in balance with society—and they are also principal factors in ensuring successful development of natural resource endowments to generate growth and to improve living standards. Failing to understand this equation can only expose projects to untenable social and environmental risk; cause governments to falter in their development mission; and deprive society of its opportunity to gain from its natural endowments. Clearly, all stakeholders must recognize and fulfill their responsibility.

The private sector is conscious that its intervention must ensure the necessary environmental safeguards and demonstrate a commitment to high standards of environmental performance. It must also subject itself to full accountability and freely disclose its policies and practices. As a starting point, understanding the project's social and environmental footprint is crucial, and project activities and operating practices must be designed to ensure they are consistent with this footprint.

At another level, pendulum swings in successive nationalization and liberalization of the oil and gas sectors in regions or countries have

A Summary Development Impact Framework for Upstream Oil and Gas Projects

Contribution to Domestic Resource Development

- Developing oil and gas reserves toward alleviating imports, or strengthening hard currency exports.
- Promoting favorable energy-mix strategies, e.g. promoting gas development as a source of relatively cheaper and more environmentally friendly fuel.
- Creating access to relatively more cost-effective sources of energy for consumers.

Contribution to Government Revenues

- Payments to governments in the form of royalties, bonuses, profit oil or gas, and taxes.
- Contributions to special purpose funds, e.g. research and development, training, etc.
- Mandatory contribution toward social welfare programs.

Contribution to Communities and Linkages

- Creating new national/local jobs.
- Fostering technology transfer, local skills development, and training.
- Sourcing national/local goods.
- Generating direct contributions to welfare of local communities and shared infrastructure.

Other Long-Term Benefits

- Growth in enabling infrastructure.
- Promoting wider participation and creating depth in the domestic oil and gas sector. Creating a more vibrant environment for investments.
- Potential demonstration impact of successful projects.

clearly emphasized how critical it is for natural resource projects to be able to demonstrate their contribution to fostering development. Failure to do so, even from factors outside the project's control, has in numerous instances crippled projects and their ability to operate.

While the scope of individual oil and gas projects varies, the potential development opportunity for the economy can be generally significant. These projects potentially contribute to helping develop domestic resources; generating revenues for the government; creating linkages in the economy; and providing benefits for communities. A broad framework of impacts that are often seen from such projects is provided in the table above.

Given this background of opportunity and risks, governments and oil and gas companies must be able to sustain a growing focus on the following core issues that are now typical of extractive industries:

- Mitigating environmental and social risks
- Governance risks to project benefits
- Maintaining transparency and disclosure
- Benefits flowing to local communities

Developers must plan their projects while keeping the above in perspective. Oil and gas projects can potentially make strong contributions to economic development. There is an increasing need—and it makes good business sense—to measure systematically and disseminate information on such contributions. Governments, for their part, must strive toward sound and transparent management of revenues from such projects, and be able to demonstrate their reinvestment in development projects that aim to improve living standards. Finally, all stakeholders share the responsibility of developing a good understanding of the risks and opportunities inherent in the oil and gas sector. This will ensure that they promote, and not impede, the creation of a strong enabling environment that fosters a successful partnership with the private sector in creating value and promoting development.

THE ROLE OF THE PRIVATE SECTOR IN PAKISTAN'S ENERGY SECTOR

Asad Umar

Pakistan's energy sector has undergone a fundamental structural change during the last decade. Private sector's participation, which was limited to the exploration and production sector until the early 1990s, has increased significantly. This growth has two dimensions:

- Establishment and entry of new companies in the private sector
- Privatization of existing public sector entities

A number of renowned foreign companies are operating in Pakistan's energy sector, including Shell, British Petroleum, Lasmo, National Power, BHP Billiton, and OMV. The private sector's participation is expected to accelerate further as the government of Pakistan continues its policy of deregulation and privatization of state-owned companies.

Exploration & Production (E&P)

Oil E&P

Pakistan had oil reserves of 309 million barrels at the end of fiscal year 2005, with oil production at 24 million barrels. This implies reserves-to-production (R/P) of 13 years, up from 12 years in fiscal year 2000.

Asad Umar is president and chief executive of Engro Chemical Pakistan, Ltd., having earlier served as senior vice president of Engro and held various professional assignments with Esso, Exxon and Engro. He currently serves as a director for the Pakistan Centre for Philanthropy; the Oil and Gas Development Company, Ltd; the Pakistan Business Council; and the Karachi Stock Exchange. He is also a member of the board of trustees of Lahore University of Management Sciences, and the board of governors of the Young Presidents' Organization in Pakistan. He has an M.B.A. from the Institute of Business Administration in Karachi.

In the oil exploration and production (E&P) sector, the public sector accounts for 50 percent of current reserves and consists of two companies, Oil and Gas Development Company (OGDC) and Pakistan Petroleum Limited (PPL). These companies together accounted for 53 percent of local oil production in FY 2005. The private sector owns the remaining 50 percent of current reserves and is dominated by British Petroleum and Pakistan Oil Fields (POL). POL is owned by Pharaon Group, whose sponsor is Ghaith R. Pharaon, an international investor and industrialist. Other private sector oil E&P operator companies include OPI, BHP, BG, MOL, ENI, OMV and Petronas.

Gas E&P

During the past five years, natural gas has become the fuel of choice in Pakistan because of local availability and lower prices as compared to oil. Gas production in Pakistan has grown at the rate of 10 percent per annum during the past five years. As of FY 2005, Pakistan had recoverable reserves of 33 trillion cubic feet (TCF), which is the equivalent of 613 MTOE. Public sector reserves stood at 16 TCF, which is 49 percent of total reserves. Two major companies in the public sector are OGDC and PPL. OGDC has 66 percent of public sector recoverable reserves while PPL controls Sui field, the largest gas field discovered in Pakistan to date. The private sector holds 51 percent of the reserves and is led by renowned multinational companies like BP, OMV, and BHP. Other companies active in gas E&P include Marri Gas, ENI, MOL, OPI, PEL, Petronas, and Tullow. During FY 2005, the private sector produced 741 billion cubic feet (BCF) of gas (55 percent of the total).

During the last three years, the government of Pakistan has sold 5 percent and 15 percent shares of OGDC and PPL (6 percent of PPL is held by IFC) respectively through public offers. Recently, the government has awarded a mandate to float 10-15 percent of shares in OGDC through global depositary receipts (GDRs) and domestic public offering. The government also plans to offload a strategic stake of both OGDC and PPL, thereby reducing its role in the E&P sector to a facilitator and regulator.

Oil Refining

Oil refining capacity in Pakistan has doubled from 6.7 million tons per annum (mtpa) in FY 2000 to 12.8 mtpa in FY 2005. This increase is primarily attributable to the establishment of two new refineries: Pak-Arab refinery (PARCO), a joint endeavor between the governments of Pakistan and the UAE, having a capacity of 4.5 mtpa; and Bosicor refinery, with a capacity of 1.5 mtpa.

At present, PARCO is the only refinery in the public sector, with 35 percent of total capacity. The remaining 65 percent of refining capacity is owned by four companies in the private sector, of which one—National Refinery (NRL), with a capacity of 2.7 mtpa—was privatized in 2005. Other companies in the private sector are Attock Refinery (ARL) and Pakistan Refinery (PRL). ARL refines only local crude; Bosicor and PARCO refine only imported crude; and PRL and NRL refine both.

OIL TRANSMISSION, DISTRIBUTION, AND HANDLING

Oil Handling & Storage

Pakistan also has a network of three oil transport pipelines. Two of these (almost 800 km each) were constructed by PARCO and carry oil from seaport to mid-country, where the PARCO refinery is located. The older of these two pipelines transports crude and has a capacity of 4.0 mtpa, while the newer one, operational since 2005, transports refined oil back along the same route. This newer pipeline was laid at a cost of $480 million and has the capacity to transport 12 mtpa. PARCO owns a 51 percent stake in this pipeline, while the rest is held by PSO (26 percent), Shell (12 percent), and Caltex (11 percent). The third pipeline carries oil from PARCO to up-country and is 360 km long. PARCO plans to construct three new pipelines totaling 710 km.

Pakistan also has a state-of-the-art oil handling and storage facility with a handling capacity of 9 million tons per annum. The terminal has an all-weather jetty capable of berthing ships of 25,000–75,000 tons deadweight. A private sector company, the Fauji Oil Terminal & Distribution Company Limited (FOTCO), operates this facility.

Oil Marketing

The largest oil marketing company (OMC) in Pakistan is a public sector company, Pakistan State Oil (PSO), which alone accounts for 60 percent of the market share and 65 percent of outlets. Shell and Caltex dominate the private sector. The public sector is the leader in furnace oil (FO), high speed diesel (HSD) and jet fuels, whereas the private sector dominates the sales of lubricants and motor spirit (MS). Recently, five new licenses have been issued to private sector companies, including Total, Attock, Admore, Hascombe, and Askar. These licensing agreements require private companies to invest $100 million over a three-year period. The government, furthermore, plans to completely privatize PSO, after which the entire oil marketing sector will be run by the private sector.

Gas Transmission & Distribution

Currently, natural gas is supplied to most consumers through a well-developed pipeline network, which has grown from 60,000 km in FY 2000 to 77,000 km in FY 2005 and handles a volume of 3.7 mcfd. The gas transmission and distribution network consists of two public utilities: the Sui Southern Gas Company Limited (SSGC) and the Sui Northern Gas Pipelines Limited (SNGPL). Some large institutional consumers, however, receive natural gas directly from the fields. Such direct supplies have increased from 8 MTOE in FY 2000 to 17 MTOE in FY 2005 at CAGR (compounded annual growth rate) of 16 percent of the total supplies. The number of industrial consumers stood at 6,000 while the total number of consumers was 4.3 million, both growing at CAGR of 4 percent over the last five years. The government also intends to privatize these utilities and deregulate the sector.

Liquefied Petroleum Gas

LPG forms only half a percentage of total energy consumption in the country. In 2005, however, an LPG plant was installed by a private sector company, Jamshoro Joint Venture Limited (JJVL), which is likely to become the country's largest LPG producer with a capacity of 500 tons per day. During FY 2005, only 36 percent of LPG was produced by the private sector in refineries and field plants. For FY 2006, this share will rise considerably due to the contribution by JJVL.

POWER GENERATION & DISTRIBUTION

Power Generation: Current Scenario

As of FY 2005, nameplate power generation capacity in the country stood at 19,400 MW. Hydel (33 percent of total) and nuclear generation (2 percent) are held entirely by the public sector. The public sector owns 40 percent of the thermal capacity of 12,400 MW, while the independent power producers account for 46 percent. KESC (Karachi Electric Supply Corporation), a recently privatized utility, owns 14 percent of generation capacity. Except for nuclear power and storage-based power generation, the government is seeking private sector investments in all types of power generation, including thermal power, run-of-the-river hydel generation, wind power, and coal-based power plants.

Power Transmission & Distribution: Background and Developing Scenario

Power generation and distribution was entirely in the public sector until the mid-1990s, in a setup where two entities, Water and Power Development Authority (WAPDA) and KESC, were the electricity producers and distributors. Since the mid-1990s, the government has been encouraging private investment, divesting its companies, and taking steps to deregulate the electricity market. The first step was the approval of WAPDA's strategic plan for privatization in 1992. WAPDA has already been divided into four generation companies (GENCos), nine distribution companies (ESCos), and the National Transmission and Distribution Company (NTDC). The next step is to privatize these entities, except for NTDC and the hydel and nuclear power stations, which will stay in the public sector. Jamshoro Power Company, Faisalabad Electric Supply Company, and Peshawar Electric Supply Company are currently planned for privatization. In November 2005, KESC, which supplies power to Pakistan's largest city, Karachi, and its adjoining areas, was privatized. KESC is an integrated power utility with four thermal plants producing 1,760 MW and a distribution network. In the first phase of the deregulation process, the generation units sell power to NTDC, which, in turn, transmits it to electric supply companies. In the second phase, all power producers will be free to sell their electricity either to NTDC or to consumers. The National Electric Power Regulatory Authority (NEPRA) will continue to exercise its tariff determination and licensing powers.

PAKISTAN'S ENERGY SECTOR: OPPORTUNITITES FOR THE PRIVATE SECTOR

LNG

Through a public sector gas distribution company, SSGC, the government of Pakistan has taken the initiative to develop an infrastructure for LNG import. In September 2005, SSGC appointed ABN Amro and Poten & Partners as consultants, while the EOI (expression of interest) submission date was set for June 30, 2006. In the first phase, a firm supply of 3.5 mtpa is targeted by 2010. The second phase involving another 3.5 mtpa will be completed by 2012. The LNG project covers LNG procurement, marine transportation, construction, ownership, operations and maintenance of an LNG import terminal and re-gasification facility. A 20-year sale/purchase agreement will be signed with the project developers. All investments in LNG import will be made by the private sector while the government's role in LNG imports will be limited to off-take guarantees by SSGC.

Coastal Refinery

The Pakistani government is encouraging private sector companies, both local and international, to set up a coastal refinery. A memorandum of understanding (MOU) has recently been signed between Pakistan and Kuwait.

Power Generation

The country has an estimated hydel potential of 42,000 MW, of which, as of June 30, 2005, the current installed capacity was just under 6,500 MW. These include dam sites and run-of-the-river projects ranging in capacity from several thousands to a fraction of one MW. The government is also seeking investment in hydel power generation.

To attract private sector investment in power generation, the Private Power and Infrastructure Board (PPIB) is playing the role of facilitator and is currently processing 45 potential projects with an 11,900 MW capacity, at a total cost of $11 billion. These projects include coal, gas, oil, dual fuel, and hydel power plants, with expected commissioning between 2007 and 2014.

Pakistan's estimated coal reserves amount to 185 billion tons, out of which the single largest field, amounting to 176 billion tons, lies in Thar, a desert region of Pakistan. This field was discovered in 1991 and remains undeveloped, except for some exploration and infrastructure development by the Pakistani government. Thar coal, which is lignite, translates into 250 billion barrels of oil based on 60 percent recovery. The biggest impediments to using this coal for thermal power are its high moisture content, ranging between 30–55 percent, and the lack of water, crucial for steam generation. One proposed method of alleviating these problems is to extract the water from the coal and use it for steam generation, at least in part. The Pakistani government has been inviting private companies, both local and international, for further exploration, study and establishment of coal-fired power plants. MOUs have been signed for a 1,800 MW capacity with an Australian group and a Chinese group. The government has also invited EOIs for a 450 MW plant at the Lakhra field, and two private sector companies have been issued LOIs (letters of intent) for a 350 MW capacity near other coalfields.

In the alternate energy arena, Pakistan has implemented a few small-scale projects for wind and solar power. Pilot projects with a total generation of 100 MW of wind power are being implemented, involving five private sector investors. Once the target is achieved, the government plans to gradually increase the capacity to about 10,000 MW by 2030. It has been estimated that a wind corridor near Gharo, Sindh, has a potential of 50,000 MW.

Privatization

The Pakistani government's plan for the privatization of the public companies in the energy sector and the deregulation of the energy market will create a level playing field for private sector enterprises. After full implementation, oil and gas E&P, oil marketing, gas distribution, thermal power generation, and power distribution will fall completely in the private sector.

Challenges

Despite its high potential, the Balochistan basin remains to be fully exploited by oil and gas exploration and production companies. The primary obstacle is the law and order situation. Delay in the privatization of the public sector energy companies is another hurdle. An unclear timeline along with the continual postponement of privatization creates an uncertainty for private sector companies, which find it difficult to plan their bids. Even though Pakistan has a large hydel potential, and several mega-storage and power generation projects have been identified and studied, this field remains marred in political controversy and disagreement amongst the provinces. The government of Pakistan needs to address this problem and achieve provincial consensus before any large projects can be implemented. Finally, there is a need to clear some ambiguities regarding the role of the government agencies, i.e. NEPRA and PPIB. The private sector, especially foreign direct investment in the power sector, can be accelerated if the PPIB is restructured as a one-window facilitator for private sector investors. Moreover, tariff determination and the negotiation process can also be improved to reduce significant delay in finalizing the new projects.

THE ROLE OF THE U.S. PRIVATE SECTOR IN MEETING PAKISTAN'S ENERGY REQUIREMENTS

JOHN R. HAMMOND

The U.S. energy industry has long been involved in the development of Pakistan's energy sector. Despite some false starts and occasional setbacks, there remains strong American interest in Pakistan's energy sector, particularly in power. This essay will discuss the current and near-future level of interest of U.S. firms; barriers to increased levels of American involvement; and actions that can remove these barriers.

DWINDLING U.S. INVESTMENT IN PAKISTAN

As indicated in the chart below, the United States has invested significantly in Pakistan for many years, accounting for as much as 37 percent of overall foreign direct investment (FDI).

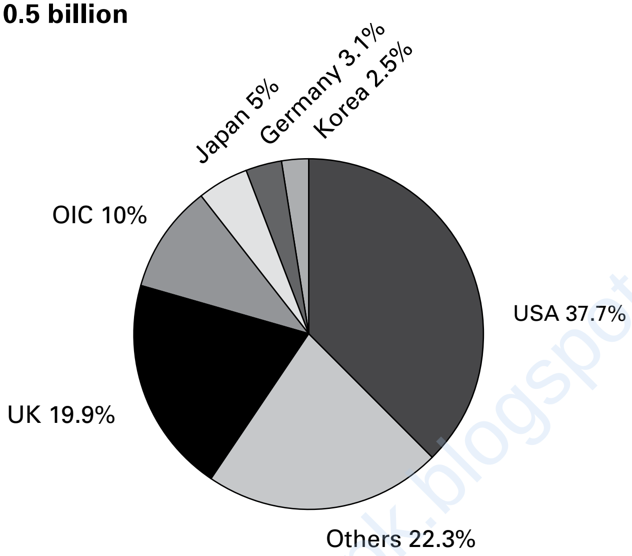
However, as one can see from the next chart, total U.S. investment in Pakistan as of 2004–2005 accounted for only $326 million, or roughly 21 percent of FDI—more than a 15 percent drop from earlier periods of American investment in Pakistan.

In 1995, there were roughly 18 U.S. energy companies interested in investments in Pakistan. These companies included: AES Corporation,

---

John R. Hammond has over 30 years of experience in management and professional consulting in the areas of private electric power generation, environmental technology transfer, and economic development in the United States and overseas. Currently he is program manager for the international energy partnership and executive exchange programs at the United States Energy Association (USEA), a nonprofit association of 160 public and private energy-related organizations, corporations, and government agencies. Founded in 1924, USEA represents the broad interests of the U.S. energy sector by increasing the understanding of energy issues, both domestically and internationally.

Pakistan: Total FDI (1990-2006)
Total: $10.5 billion



Source: State Bank of Pakistan

FDI Inflows (2004-05)

Source	Million $
UAE	367.5
USA	326.0
UK	181.5
Switzerland	137.5
Japan	45.2
Netherlands	36.7
Others	429.7
Total	**1,524**

Source: Government of Pakistan, Board of Investment

American Electric Power (AEP), Amoco, Bechtel, Besicorp, Coastal, Destec, Enron, General Electric, Houston Industries, K&M Engineering, Mission Energy, NRG Energy, Occidental, Ogden Products, SCECorp, Smith Cogeneration, and Southwestern Public Service. These companies were primarily interested in independent power projects.

However, in more recent times the situation regarding U.S. investment in Pakistan has changed. The number of American energy companies currently involved in Pakistan has shrunk to a mere five or six. The major catalysts for this change have been competition from a strong U.S. market; the restructuring of the U.S. energy industry; and increased political and security concerns relating to Pakistan.

U.S. Domestic Energy Competition

A strong domestic market has captured the attention of most American companies. U.S. energy needs for power, gas, oil imports, and other energy infrastructure have soared. By 2030, as the chart below indicates, North American power investments are expected to reach $3.5 trillion. Major investment areas include nuclear power (25 plants); transmission ($28 billion, 2003–2008); natural gas distribution ($8 billion per year); and oil ($622 billion, 2001–2030).

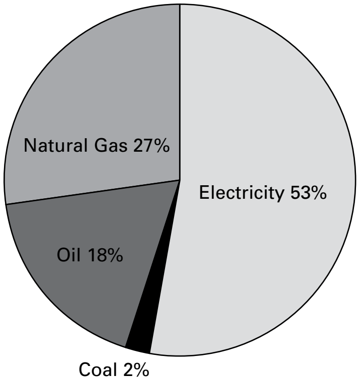
There are also roughly 25 liquefied natural gas (LNG) terminals planned in North America, of which 5 or 6 are expected to be developed in the near future. Additionally, the 2005 Energy Policy Act has created tax incentives in the amounts of $2.6 billion for the oil and gas sectors; $9 billion for electricity reliability; and $2.6 billion for renewables, efficiency, and conservation.

Finally, many new power plants in the United States are now experiencing a shift away from using natural gas and toward using coal. This shift necessitates investments in replacing existing mining operations with new mines, expanding existing mines, or simply sustaining existing mining operations.

U.S. Power Industry Restructuring

Restructuring in the power industry has significantly reduced the industry's appetite for international investments. An economic downturn in the domestic industry has led to mergers and acquisitions and a return to traditional business lines, such as investments in domestic power plants,

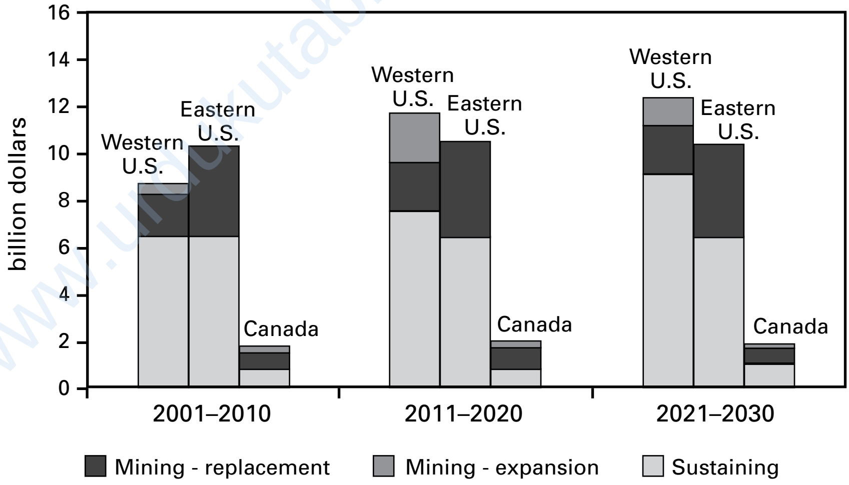
Organization for Economic Cooperation and Development (OECD) Estimate of North American Energy Investment by Fuel 2001–2030



Cumulative Investment = $3.5 trillion

Source: International Energy Agency

Coal Mining Investment by Region in the United States and Canada



Source: International Energy Agency

transmission lines, and distribution systems. Other industry changes include the segregation of utilities and independent power producers (IPPs) and failures in international ventures. These changes have translated into an overall withdrawal from overseas markets and increased risk aversion. Furthermore, these factors have been compounded by increased political and security risks overseas.

The unbundling of generation assets from formerly vertically integrated utilities has resulted in a decreased number of players in the independent power market domestically and overseas. The recent financial difficulties of U.S. power companies, including the Enron debacle, have forced American IPPs to retrench and avoid foreign exposure. Additionally, the disappointing results—and even failure—of U.S. IPP investments overseas during the last 10 years have soured investors, stockholders, and lenders in many international markets.

Political and Security Concerns

Finally, there is a perception in the U.S. energy industry that the political and security risks in developing countries have dramatically increased since the events of September 11 and the war in Iraq. While these are always significant factors, they have now become of much greater concern to corporate management than they were before. Companies are now more cautious about employee safety. They also worry about sending the wrong signals to their equity investors when proposals are made to invest in projects in developing countries.

INVESTMENT OPPORTUNITIES IN PAKISTAN AND RECOMMENDED APPROACHES

Pakistan will require an additional 143,310 megawatts of electricity by 2030, which means there are significant opportunities for interested investors.[1] It should be noted, however, that opportunities for U.S. investments in the oil and gas sectors are more limited, due to an existing prevalence of Middle Eastern companies in those two areas.

A number of barriers inhibit U.S. investment in Pakistan's energy sector today:

USEA International Energy Partnership Program

In conjunction with the U.S. Agency for International Development, the United States Energy Association (USEA) sponsors the Energy Partnership Program. USEA has organized over 80 volunteer partnerships between U.S. utilities and regulatory commissions and their counterparts in developing and transitional economies. Through these partnerships, U.S. organizations have donated their time to transfer U.S. experiences and market-based "best practices" to other nations.

USEA has partnerships in Latin America, Africa, Asia, the former Soviet Union, and Central and Eastern Europe on topics ranging from regulation to electric power production. These partnerships are considered one of the most successful foreign assistance programs ever created, with U.S. companies contributing over $25 million in-kind contributions from U.S. energy executives. Examples of partnership results include: reducing losses; accelerating reform; improving generation efficiency; improving equipment and maintenance; and the introduction of advanced management systems.

USEA currently has a partnership with the Pakistan National Electric Power Regulatory Authority (NEPRA). The primary objectives of this partnership are: tariff design and incentives; creating, monitoring, and enforcing performance standards; and open access to transmission. Some of the results the partnership has already yielded include: the transfer of a service quality monitoring program; the introduction of competitive market concepts and practices; and the introduction of accelerated dispute resolution processes. This partnership will help to improve the climate for U.S. investment through the transfer of best practices. Additional partnerships with the Pakistan utilities would only increase this potential.

- not as much awareness in the United States as in the past about Pakistan's energy market and regulatory structure
- the preference in the United States for sales of goods and services versus investments
- financing difficulties due to political and financial risks

Should Pakistan wish to increase the U.S. presence in its energy structure, it should look to American firms with current investments in Pakistan's energy sector. It also needs to demonstrate to the investing world what is referred to as the "show me element." That is, Pakistan must demonstrate successful, unaltered IPP investment projects that operate without government interference in contractual agreements. Pakistan should also be willing to accept "contracting" versus full privatization, as well as to bolster commercialization through the adaptation of best practices. This would go a long way toward reducing political and financial risks in the minds of investors—undoubtedly the foremost impediments to potential investments.

Another approach is to concentrate on adapting best practices for state-owned utilities. This could involve partnerships between energy organizations and companies in Pakistan that transfer ideas and best practices from U.S. companies. The International Energy Partnership Program is one example; a description is at left.

Although there are significant barriers to increased U.S. investment in Pakistan's energy sector, Pakistan's government appears to be taking steps—such as establishing an improved regulatory framework and offering additional incentives for new investments—on many fronts to overcome these obstacles. It is anticipated that the medium-term investment climate in Pakistan will improve for American companies.

NOTES

1. See "Pakistan needs $150b to meet future power demand," *Daily Times*, June 11, 2005, available from http://www.dailytimes.com.pk/default.asp?page=story_11-6-2005_pg5_16.

U.S. CHAMBER OF COMMERCE ENERGY OVERVIEW FOR THE ISLAMIC REPUBLIC OF PAKISTAN

ARAM ZAMGOCHIAN

South Asia is entering an extended period of transition as it strives to implement effective economic, political, social, environmental, and legal structures to support sustained growth. In particular, the International Monetary Fund (IMF), World Bank, and Asian Development Bank have all recognized the urgent need to provide long-term guidance and assistance during this critical period of transformation. Thus the IMF and World Bank have made available several billion dollars worth of assistance to the region through a structural adjustment program. The IMF prescribes such measures as cutting energy subsidies, unbundling and deregulating the electricity and natural gas sectors, and increasing privatization of basic infrastructure services as pre-conditions for access to such funding. While the pace of reforms and availability of resources vary throughout the region, Pakistan has progressed credibly in opening up its energy and power sectors, and putting in place many of the policies necessary to encourage foreign direct investment. Below is the U.S. Chamber of Commerce's broad, seven-criteria assessment of Pakistan's power sector.

Aram Zamgochian is the director of South Asia affairs at the U.S. Chamber of Commerce, the world's largest business federation. He is responsible for providing Chamber members and affiliates with first hand knowledge of the political, social, business, economic, and competitive dynamics of the countries within South Asia. Previously, he served as the U.S. Chamber's resident project director in India for the South Asia Regional Energy Coalition, a business advocacy organization through which public and private sector stakeholders influence regional energy policy and reform across South Asia. This program was funded by the U.S. Agency for International Development's South Asia Regional Initiative/ Energy program, launched in 2000 to build mutually beneficial energy linkages among the countries of South Asia.

AVAILABLE RESOURCES

Coal

Coal reserves currently being developed in Pakistan have enormous economic potential. The country's coal production in 2003 was 3.7 million short tons. According to ongoing detailed assessments, recoverable coal reserves are estimated to be 3,362 million short tons.[1] Coal's relatively minor role in Pakistan's energy mix could increase in line with recent discoveries of large volumes of low-ash, low-sulfur lignite in the Tharparkar Desert of the Sindh province.[2] In February 2005, Pakistan's government established a five-member committee, consisting of environment ministers and the chairmen of Sindh Coal Authority, to fully utilize coal reserves and to facilitate foreign investment in coal extraction.[3]

Oil

In 2005 Pakistan produced 61,500 barrels of oil per day. Proven oil reserves are 341.8 million barrels, according to 2005 estimates.[4] Crude oil production in 2005 stood at 60,270 barrels (98 percent of total oil production), representing 17 percent of the country's overall oil demand.[5] The capacity of Pakistan's current oil refinery is 12.8 million tons per year.[6] Oil reserves are mainly found in the Potwar Plateau, Punjab, and lower Sindh province. Although Pakistan is unlikely to reach self-sufficiency in oil (82.5 percent[7] of oil consumed is imported), the government has encouraged domestic and foreign private firms to develop oil production capacity.[8] In addition, current government policy is to deregulate the oil industry and establish regulatory agencies and price caps on petroleum products.[9] No significant new discovery of crude oil has been reported recently, although both national and international exploration and development companies are striving to discover new oil sites.

Natural Gas

Proven gas reserves in Pakistan total 26.8 trillion cubic feet,[10] with yearly production reaching 840.5 billion cubic feet.[11] The largest natural gas fields are Sui (650 million cubic feet per day); Adhi and Kandkhot (120 million cubic feet per day); Mari; and Kandanwari. Exploration and development of new natural gas fields are expected to add about one billion cubic feet per day to Pakistan's natural gas production.[12]

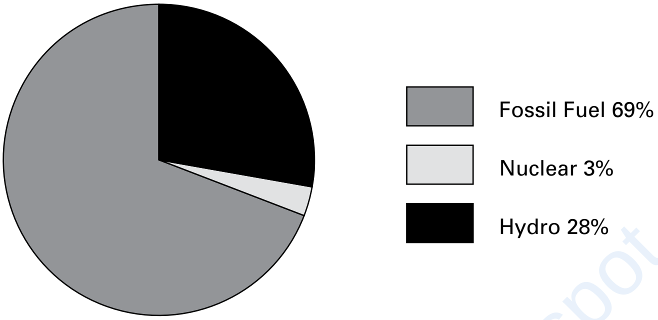
Nuclear Energy

Nuclear power supplies only 2.4 percent of the country's electricity—a small contribution to total energy production and requirements. The Pakistan Atomic Energy Commission is responsible for all nuclear energy and research applications in the country. Pakistan has two operating nuclear power plants—in Karachi (KANUPP) in Sindh, and in Mianwali (CHASNUPP) in Punjab.[13] The KANUPP plant has generated over 10.5 billion KWh of electricity since it became operational in 1971, while the CHASNUPP power plant has generated over 3.5 billion KWh of electricity since it was connected to the national grid in 2000. In 2005 an Energy Security Plan was adopted by the government, calling for a huge increase in generating capacity to more than 160,000 MWe by 2030. It includes plans for lifting nuclear capacity to 8400 MWe, 900 MWe of this by 2015.[14] Pakistan, with the aid of China, has begun work on a third nuclear reactor at Chasma.[15] The government has also announced plans to build two further Chinese reactors, of 600 MWe each.[16]

Renewable Energy

Although Pakistan faces substantial challenges to meet its present energy demand with primary supplies, renewable energy sources can play an important role in meeting the country's deficit. Technologically viable renewable resources include micro-hydel, bio-energy, wind, and solar energy. Pakistan, with its plentiful sunshine, is in an ideal position to take advantage of solar energy technologies. Sunshine provides 1.9-2.3 MWh per meter squared each year.[17] According to letters of commitment received by leading investors in May 2006, 650 megawatts of wind power would be injected into the national grid by the end of 2007.[18] Similarly, northern Pakistan has significant hydropower resources, including 12 already developed hydropower plants with capacity of one MW or greater, and abundantly available natural and manageable waterfalls. Recoverable micro-hydropower potential based on these perennial waterfalls is estimated to be roughly 300 MW. Wind is another potential source of energy, although current data is insufficient and wind turbines for power generation have not yet been installed.[19] Demand for power is expected to be 15,483 MW in 2006 and to increase to 20,584 MW by 2010. Pakistan has a firm supply of 15,072 MW for 2006, and will be forced to continue

Electricity Production by Source



importing to meet power demands without future investment in energy sources.

INFRASTRUCTURE

When Pakistan's 1994 power policy opened up the energy sector to private investment, investments in transmission and distribution were not in parallel with those made to increase generation. As a result, infrastructure remained underdeveloped. Some of the power generated by private plants could not be properly dispatched, and had limited access. Pakistan's poor quality infrastructure causes an estimated 30 percent loss of transmission per year.[20] Line losses are 21.4 percent[21] at the Water and Power Development Authority (WAPDA) plant and 40 percent at the Karachi Electric Supply Corporation (KESC) plant.[22] Despite improvements in WAPDA, power theft is estimated to be Rs. 24.7 billion per year.

EXPORT POTENTIAL

In fiscal year 2004-2005, Pakistan's exports reached $14.85 billion, a 7 percent rise over FY 2003-2004.[23] This increase was attributed to consistent government policies and incentives to exporters. A 63 percent jump in the export of petroleum, oil, and lubricants contributed significantly to these figures. Development of pipelines and other infrastructure could further facilitate the region's energy exchange. Pakistan's current power policy seeks to increase energy exports through such features as income tax exemptions, including turnover-rate tax and withholding tax on imports for projects based on indigenous fuel.[24] Pakistan's demand for gas has increased rapidly, and the government plans to focus on natural gas for future electric power generation projects—thus generating interest in pipelines to facilitate imports from neighboring countries. Pakistan's government has stated that it would permit a natural gas pipeline across its territory that links Iran's reserves to India, although India has been reluctant while political and military tensions over Kashmir persist. A gas pipeline to link Turkmenistan to Pakistan via Afghanistan also has potential.[25]

Access to Market

Pakistan has been slow to exploit energy resources, due to capital shortages and domestic and international political constraints. For instance, domestic gas and petroleum production constitute only about half the country's energy needs, and dependence on imported oil contributes to Pakistan's persistent trade deficits and shortage of foreign exchange. At present, the power generation sector and the oil and gas sectors are open to foreign investment.[26] The government has announced that privatization in oil and gas is a priority.[27]

As part of that process, and in response to conditions laid down by lenders such as the IMF and the World Bank, the government of Pakistan continues to strive towards privatizing its state-owned companies. The government is offering a 51 percent stake of Pakistan Petroleum, Ltd., the largest exploration and production firm in Pakistan. Currently the government controls 93 percent of the company, which owns the Sui fields in Balochistan, as well as exploration interests in 22 blocks. Furthermore, the state-owned Pakistan State Oil, which holds a 60 percent domestic market share in diesel fuel and has more than 3,800 retail outlets, also has a 51 percent stake of its holdings up for sale. In addition, the Pakistani government divested a 5 percent stake of its stock in Oil and Gas Development Company, Ltd., another leader in the Pakistani oil industry, with current production around 31,350 barrels of oil per day.

In addition to the sale of state-owned businesses as part of the country's privatization process, Pakistan is setting up a Gas Regulatory Authority and Petroleum Regulatory Board. These entities will work to separate out government functions from state-owned companies to be privatized. Pakistan's government hopes to reap significant revenues from these privatizations over the next several years. Sub-sectors of the energy sector, such as petroleum, have also been restructured so as to increase private participation.

The electric power sector in Pakistan is still primarily state-owned. A privatization program is underway, but little progress appears to have been made to date. The main state-owned utilities are WAPDA and KESC, which serves Karachi and surrounding areas. Together, WAPDA and KESC transmit and distribute all power in Pakistan. Over half of the electricity goes to household consumers, about one third to industrial consumers, and the rest to commercial and government consumers. Rates are determined by the National Electric Power Regulatory Authority, with disputes over rate adjustments common within the industry. The government of Pakistan continues to seek reform in the state-held electric companies, but efforts in that direction continue to stall. Plans have been made to transform WAPDA into three generation companies, eight distribution concerns and a transmission entity, with the hope of seeing it privatized. In addition, the government has sought the sale of KESC to private investors, who so far have been slow to take it on because of the cost of rehabilitation, modernization and expansion.[28] Currently, independent power producers and small private operators are able to generate electricity and sell to the national grid.[29] The government's power policy envisages additions in power generation through competitive bidding for specific sites and types of plants. Resource mobilization in the private sector is considered essential to meet the government's development targets.

ENERGY POLICY

The government of Pakistan has prioritized the oil and gas sector for the country's development. Pakistan has faced chronic energy shortages in the past, and domestic energy demand has outstripped supply. Privatization and reforms in the oil sector are progressing steadily. Deregulation of prices for petroleum products is being pursued in parallel with the privatization of Pakistan State Oil. Power theft is a significant problem in Pakistan; in the past, the government has assigned army units to look for illegal connections to transmission lines.[30] The government has also identified a need to improve the socio-economic conditions in remote areas through renewable energy technologies, and has emphasized them in its recent development plans.[31] However, practical measures—such as incentives and funds for the demonstration of renewable energy technologies—are wanting.

CONSUMPTION

Pakistan's energy consumption has tripled in the last 20 years, from 0.6 quadrillion Btu in 1980 to 1.9 quads in 2001. Per capita energy consumption in 2001 was 12.9 million Btu.[32] Electricity consumption increased by approximately 8.6 percent in the first nine months of FY 2002-03. More than three-quarters of Pakistan's commercial energy consumption is accounted for by oil and gas. In 2003 Pakistan consumed 16.45 million tons of petroleum products. Net oil imports are projected to rise substantially as growth in demand outpaces increases in production. Imported oil accounts for 83 percent of oil consumed in Pakistan, while indigenous oil is 17 percent.[33] Within the next five years, demand for natural gas is also expected to rise significantly—50 percent by 2006, according to Pakistan's oil and gas ministry.[34] Pakistan's largest electricity consumer is the oil and gas sector.[35] Demand for electricity is likely to grow in the long term, given the substantial economic growth in manufacturing. Only 60 percent of the population has access to electricity, and less than half of the population is connected to the national grid. Many rural areas have yet to receive electric power. [36]

ENVIRONMENT

The unchecked use of hazardous chemicals, vehicle emissions, and industrial activity caused by economic development have contributed to environmental problems. In 2001 energy-related carbon emissions totaled 29.2 million metric tons. However, this figure (although triple the 1980 level of 9.3 million metric tons) represents only 0.4 percent of the world's total carbon emissions, and the level of emissions is significantly lower than in neighboring countries such as Iran and India. Industrial waste and agricultural runoff have contaminated drinking water supplies, and legislation to protect Pakistan's mountain ranges and areas of untouched wilderness from industry pollution has passed only in the past 10 years.[37]

NOTES

1. Energy Information Administration, U.S. Department of Energy, "World Coal Markets," in *International Energy Outlook 2006*, 51-61, available at http://www.eia.doe.gov/oiaf/ieo/pdf/coal.pdf.

2. Ibid.

3. "Body set up to exploit coal reserves," *Dawn* (internet edition), February 20, 2005, available at http://www.dawn.com/2005/02/20/ebr6.htm.

4. *CIA World Factbook*, http://www.cia.gov/cia/publications/factbook/rankorder/2178rank.html.

5. Energy Information Administration, "Pakistan," *Country Analysis Briefs*, last updated November 2005, available at http://www.eia.doe.gov/emeu/cabs/Pakistan/pdf.pdf, 7.

6. "$2 billion mega oil refinery planned," *Dawn* (internet edition), April 15, 2006, available at http://www.dawn.com/2006/04/15/ebr1.htm.

7. World Energy Council, "Interfuel Substitution for Resource Optimization and Sustainable Development: Pakistan's Case Study," 19th World Energy Congress, Sydney, Australia, September 5-9, 2004, available at http://www.worldenergy.org/wec-geis/congress/papers/razah0904.pdf#search='oil%20consumed%20imported%20indigenous%20oil%20pakistan', 2.

8. "Pakistan Country Analysis Brief," *Alexander's Gas & Oil Connections, News & Trends: E & SE Asia*, vol. 8, no. 11 (June 3, 2003), available at http://www.gasandoil.com/goc/news/nts32304.htm.

9. Board of Investment, Government of Pakistan, "Oil & Gas Sector In Pakistan," available at http://www.pakboi.gov.pk/Industry_Data/oil___gas1.html.

10. Energy Information Administration, November 2005, 3.

11. CIA World Factbook, http://www.cia.gov/cia/publications/factbook/rankorder/2180rank.html.

12. Energy Information Administration, November 2005, 3.

13. World Nuclear Association, "Nuclear Power in India and Pakistan," June 2006, available at http://www.world-nuclear.org/info/inf53.htm.

14. Ibid.

15. "Pakistan builds new nuclear plant," BBC News, international version, May 4, 2004, available at http://news.bbc.co.uk/2/hi/south_asia/3683621.stm.

16. World Nuclear Association, *Weekly Digest*, December 30, 2005, available at http://www.world-nuclear.org/news/2005/pdf/WNA_Weekly_Digest_12-30.pdf.

17. World Energy Council, "Country Reports: Pakistan," in *Renewable Power in South Asia,* available at http://www.worldenergy.org/wec-geis/publications/reports/renewable/country_reports/chap_2_6_2.asp.

18. "Pakistan Makes Goal of 650 MW Wind Energy by 2007," *Renewable Energy Access Newsletter,* May 24, 2006, available at http://www.renewableenergyaccess.com/rea/news/story?id=44993.

19. World Energy Council, "Country Reports: Pakistan."

20. Energy Information Administration, November 2005, 5.

21. "Tariff issue delaying Fesco sell-off: Wapda," *Dawn* (internet edition), April 24, 2006, available at http://www.dawn.com/2006/04/24/nat24.htm.

22. Sultan Ahmed, "Preventing Power Losses," *Dawn* (internet edition), January 19, 2006, available at http://www.dawn.com/2006/01/19/op.htm.

23. CIA World Factbook, http://www.cia.gov/cia/publications/factbook/rankorder/2180rank.html.

24. Board of Investment, Government of Pakistan, http://www.pakboi.gov.pk/Industry_Data/oil___gas2.html.

25. Energy Information Administration, November 2005, 4.

26. Commercial Service, U.S. Department of Commerce, "Pakistan Investment Climate Statement," last updated September 16, 2002, available at http://www.buyusa.gov/pakistan/en/52.html.

27. U.S. Department of State, Bureau of South and Central Asian Affairs, "Background Note: Pakistan," October 2006, available at http://www.state.gov/r/pa/ei/bgn/3453.htm.

28. Energy Information Administration, November 2005, 6.

29. Engr Hussain Ahmad Siddiqui and Engr Jawaid Iqbal Mufti, "Independent producers to develop hydro power projects," *Dawn* (internet edition), October 11, 2004, available at http://www.dawn.com/2004/10/11/ebr13.htm; Energy Information Administration, November 2005, 6.

30. "Pakistan Country Analysis Brief," *Alexander's Gas & Oil Connections.*

31. Energy Information Administration, November 2005, 6.

32. Energy Information Administration, "Pakistan: Environmental Issues," in *Country Analysis Briefs*, August 2003, available at http://www.eia.doe.gov/emeu/cabs/pakenv.pdf.

33. World Energy Council, "Interfuel Substitution," 2.

34. "Pakistan Country Analysis Brief," *Alexander's Gas & Oil Connections.*

35. World Energy Council, "Interfuel Substitution."

36. United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Environment and Sustainable Development Division, Energy Resources Section, "Pakistan," available at http://www.unescap.org/esd/energy/information/electricpower/2001-2002/html/pakistan.htm.

37. Energy Information Administration, August 2003.

CLEAN ENERGY OPTIONS FOR RURAL PAKISTAN: LESSONS FROM SOUTH ASIA

Bikash Pandey

Pakistan is a net importer of energy. Each year it spends U.S.$3 billion, equivalent to about 30 percent of total imports, in order to meet its energy needs. Oil import expenses are a heavy burden on the country's foreign exchange. Recent increases in oil prices and their continuous fluctuation further augment this burden. Most of the imported energy is for electricity generation. Over 70 percent of Pakistan's electricity comes from thermal sources, a little less than 30 percent from hydro, and less than 1 percent from renewable and other sources. Despite its energy imports, Pakistan currently faces a 20 percent power shortage. Only 59 percent of Pakistan's population has access to electricity from the national grid. In rural areas, the percentage with electricity access falls to 37 percent. The majority of the rural population uses kerosene, wood, and other bio-fuels for lighting, cooking, and heating. Pakistan has among the lowest per capita consumption of energy in the world.

Pakistan's renewable energy potential is substantial and the vast majority of it remains untapped. Its potential for hydro-electricity from run-of-the-river micro, mini, and small hydropower schemes from perennial streams, and the extensive irrigation canal system have not yet been fully measured. Although a number of successful projects have been demonstrated in small communities and for connection to the national grid,

---

Bikash Pandey is the director of the South Asia Clean Energy program of Winrock International, and is currently based in Islamabad. He has 20 years of experience in designing, implementing and reviewing a range of renewable energy projects in developing countries, including Nepal, the Philippines, Kenya, Sri Lanka, and Afghanistan. From 1998 to 2005, he was the Clean Energy group director in Kathmandu, where he developed proposals and managed a team of a dozen to promote clean energy in Nepal. He received his B.S. degree in electrical engineering from Massachusetts Institute of Technology and his M.S. in energy and environment from the University of California at Berkeley.

large scale adoption of the technology has not taken place. Pakistan's potential for wind has not yet been fully measured, but the government of Pakistan has installed 50 towers, 30–100 feet high, in the coastal areas of Sindh and Balochistan and in the desert of Balochistan, to measure wind velocity. The potential for solar energy, although not yet determined, is also thought to be very good throughout the country.

The government of Pakistan has decided to place greater emphasis on renewable energy (RE). In May 2003, the government announced that it had set a target of 10 percent, or 2,700 megawatts, of the country's energy mix to come from renewable energy by 2015, and established the Alternative Energy Development Board (AEDB) as the apex organization to coordinate renewable energy promotion. To underscore the importance of this initiative, AEDB was set up in the prime minister's secretariat and was to report directly to the prime minister. A number of initiatives have already been taken by AEDB to expand the availability of renewable energy technologies (RETs) both for the grid and for isolated off-grid applications. One hundred megawatts of wind energy are under construction at Gharo-Keti Bander, with this corridor in Sindh alone estimated to have a potential of 50,000 megawatts of wind energy. AEDB intends to have 700 megawatts of wind installed by 2010. To meet the needs of rural households and institutions, 140 micro wind turbines of 500 watt capacity have been installed.

A pilot project has been launched to produce bio-diesel and develop a commercial program. Using solar home systems through micro-finance, 400 villages are being electrified. The government of Pakistan has been able to put in place a number of market-based and fiscal incentives for RE. These include accelerated depreciation for investors and low import duties and taxes for RE technologies already in place in Pakistan. However, international experiences indicate that unless equal opportunities are made available to RE as are enjoyed by conventional energy (primarily thermal power from oil or coal), the establishment of renewable energy will be very difficult, and the government will not be able to meet its goal of deriving 10 percent of its energy mix from RE sources by 2015. For example, there are hidden subsidies on the fuel costs for conventional power generation that allow for lower generation costs. In addition, the costs of environmental externalities from pollution are generally not included in the pricing of power from conventional power generation.

AEDB is preparing several additional market-based incentives such as the introduction of tax holidays, further reducing import duties on a greater range of technologies in order to attract investments in renewable energies and establish renewable energy manufacturing facilities in Pakistan. AEDB is also working on a pricing structure for RE based on a cost-benefit analysis which will allow RE to compete with conventional energy. To address the energy shortage, and as part of its decentralization policy, the government also delegated authority to the provinces to develop their own generating capacity of up to 50 megawatts to meet their energy needs. Installation of small-scale power generation technologies located close to the load being served, or distributed generation, has significant advantages. It will not only help meet the power shortage, but also ensure greater power reliability and quality.

ENERGY AND POVERTY

The lack of access to modern energy services is inextricably linked to poverty and the lack of fulfillment of basic needs such as shelter, food, health care, education, secure land tenure, access to agricultural inputs, credit, information, and political power. Poverty in the Asia-Pacific region is closely associated with low levels of access to electricity. Nearly one-third of the population in Asia's developing countries, more than a billion people, had no access to electricity in 2000. The average electrification rate in South Asia (41 percent) is less than half the average for East Asia, including China and the Pacific (86 percent).

The challenge of meeting energy needs for rural people in developing countries transcends electricity. Energy is needed for a variety of household uses, such as cooking, lighting, space heating, and other appliances; for agricultural uses, such as tilling, irrigation, and post-harvest processing; and for rural industry uses, such as milling and mechanical energy and process heat. Energy is also an input to water supply, communication, commerce, health, education, and transportation in rural areas. Higher-income communities generally use more efficient and more convenient sources of energy, such as gas and electricity, whereas lower-income people use less efficient and less convenient sources, such as fuelwood and human energy. In this section, we discuss the key challenges in meeting the energy needs of the poor.

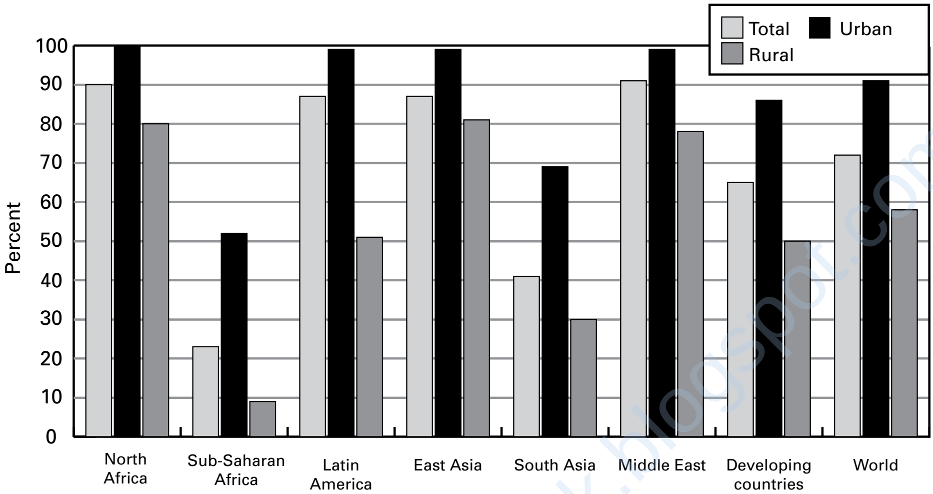
AFFORDABILITY: THE POOR PAY HEAVILY FOR ENERGY SERVICES

In general, people living in poverty expend more time and effort to obtain energy services that tend to be of lower quality than the energy services available to the rich. Poor people pay a high price—in cash or in labor—for the energy they use. They spend a much greater share of their household income on energy than do wealthy people because their incomes are much lower as well as because the fuels they use are much less efficient than modern fuels. The share of energy in the total spending of low-income households is as high as 15 percent of income.[1] Energy spending rises with income, but generally at a less than proportional rate. A survey conducted in Bangladesh in 1998 revealed that 39.34 percent, 18.67 percent, and 4.17 percent of the respondents were spending above US$ 3.1, 4.0 and 7.5, respectively, per month on lighting and battery charging.[2]

The Rural-Urban Divide in Energy Consumption

The vast majority of the poor continues to inhabit rural areas with no or minimum access to electricity and can only afford a modicum of modern fuels like kerosene for essential lighting. Electricity and fossil fuels rely on capital-intensive distribution networks (transmission and distribution grids or pipelines and bulk transport by road or rail) to deliver centrally produced supplies to rural areas. Rural electrification programs have typically involved extending the grid incrementally, moving from large demand centers to smaller ones, reaching towns and settlements in order of increasing capital costs. The farther these areas are from the reach of such networks, the greater the technical and economic difficulties faced by energy supply utilities that have to operate on financial sustainability principles in order to remain viable. Under the circumstances, the primary problem for the poor is their inability to access modern energy because supplies simply do not reach them. In South Asia, only 30 percent of the rural population has access, compared with 68 percent of the urban population.

Figure 1: Share of Population with Access to Electricity by Region



Source: J. Saghir, "The global investment challenge – financing the growth of renewable energies in developing countries," Renewable Energy World *8 (2005): 4, 196-211.*

Reliance on Traditional Fuels is a Question of Choice

In spite of the efforts in renewable energies, traditional use of biomass continues to account for the largest share of total primary energy supply in many developing countries.[3] Nearly 2.4 billion people in developing countries still rely on wood, agricultural residues, and dung for cooking and heating (Figure 2). Biomass accounts for a large share of total primary energy supply in many developing countries. In 2001, this share was 49 percent in Africa, 25 percent in Asia, and 18 percent in Latin America. Even though biomass fuels, especially when collected, cost little in terms of cash, they have huge social, environmental, and health costs. Past trends indicate that even though fossil fuels are the fuel of first choice for most poor people, biomass fuels are likely to remain the main fuel of necessity. Projections show that the number of people relying on biomass fuels will grow to 2.6 billion by 2030.[4]

Figure 2: Biomass Dependence for Cooking and Heating in Developing Countries, 2000

Country or region	Millions	Percentage of population
China	706	56
Indonesia	155	74
East Asia (excluding China and Indonesia)	137	37
India	585	58
South Asia (excluding India)	128	41
Latin America	96	23
Middle East and North Africa	8	1
Sub-Saharan Africa	575	89
All developing countries	2,390	52

Source: International Energy Agency, "Energy and Poverty," in World Energy Outlook 2002 *(Paris: International Energy Agency and the Organisation for Economic Cooperation and Development, 2002), available from http://www.iea.org/textbase/nppdf/free/2000/weo2002.pdf.*

The Gender Dimension of Energy Poverty

Women and children usually form the majority of poor people in any community; 70 percent of the 1.3 billion people living in poverty are women. Rural women and their children are the primary collectors of wood and residue fuels, which account for 80 percent of all household energy usage in many developing countries. Rural women use significant quantities of energy in their day-to-day subsistence tasks and in home-based enterprises; the viability of these activities is affected by energy prices and availability. Gender bias is a further reflection of energy's largely non-monetized attributes among the poor, since much of women's work is characteristically unpaid work. Poor women are also disproportionately the victims of energy scarcity, which is expressed in their poor nutritional status (since fuel availability affects cooking habits and food availability) poor health due to indoor air pollution, and even low literacy rates, which could be attributed to the fact that girls are more likely than boys to assist their mothers gathering fuelwood or drinking water.

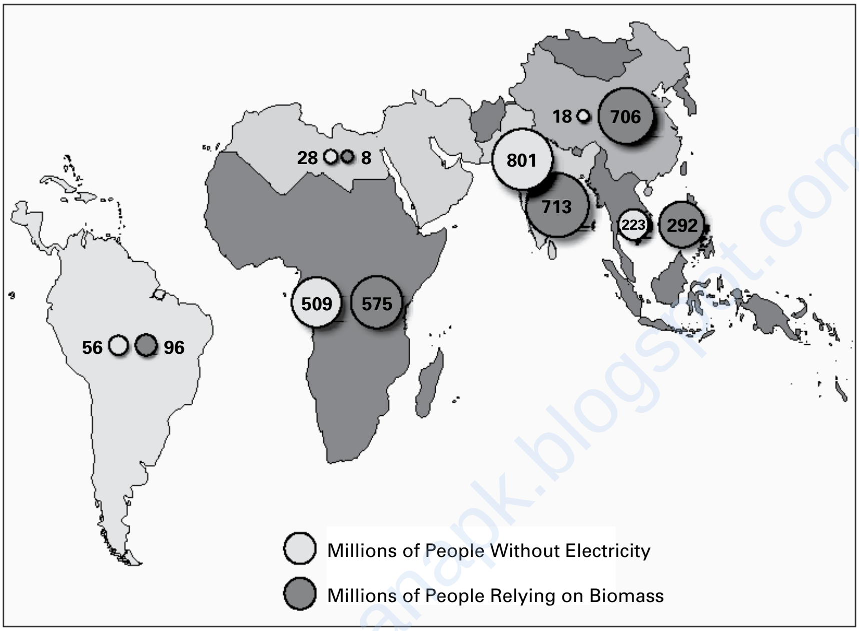
Regional Disparities

Energy consumption patterns vary in different parts of the world. In 2005, average annual per capita consumption of modern energy (i.e., excluding traditional biomass and additional waste) was 1,519 kilograms of oil equivalent (kgoe). While the average in high income countries was 5,228 kgoe, in low-income countries it was only 250 kgoe.[5] Traditional biomass and waste account for 10.6 percent of total global primary energy supply. However, the distribution is uneven; traditional energy accounts for less than 3.4 percent of energy use in industrialized countries but an average of 17.9 percent in developing countries.[6] In low-income countries, these sources represent, on an average, 49.4 percent of the supply, with some countries approaching 90 percent. The World Bank's 2004 estimates point to a scenario where the richest 20 percent of the world's population consume 58 percent of the world's total energy, whereas the poorest 20 percent consume less than 4 percent.[7] The majority of those underserved are the poor in sub-Saharan Africa and South Asia. (See Figure 3.)

GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENTS

Global renewable energy markets have grown tremendously in the last decade. Annual investment in renewable energy has grown almost fourfold from US $6 billion in 1995, while cumulative investment since 1995 is on the order of $110 billion. The markets for new renewable energy are expected to approach $85 billion annually within the next decade. The annual investment in the renewable sector has been on the order of $30 billion, roughly 20-25 percent of global power sector investment. This means one in every four projects in the power sector is a renewable energy project. Annual private investment into renewable energy projects had already achieved substantial levels even before the dramatic increase in the price of petroleum over the past 18 months, roughly one in every four dollars invested in the power sector.

Figure 3: Global energy poverty


18
706
28
8
801
713
223
292
509
575
56
96
Millions of People Without Electricity
Millions of People Relying on Biomass

Source: International Energy Agency, "Energy and Poverty," in World Energy Outlook 2002 *(Paris: International Energy Agency and the Organisation for Economic Cooperation and Development, 2002), available from http://www.iea.org/textbase/nppdf/free/2000/weo2002.pdf.*

Sustained high fuel prices can be expected to accelerate this further. Much of this investment has been concentrated either in OECD countries or in a few developing countries such as China, India, and Brazil, with most of the investment volume in renewable energy being driven by energy security and environmental concerns.

This trend is likely to continue in the immediate future. The success of these lead countries in increasing the percentage of renewable power on their grids is already being replicated in a small number of other developing countries that have established feed-in tariffs, net metering, standard power purchasing agreements, and the availability of bank financing. Many of these emerging market countries are also leaders in nationwide programs to produce and use biofuels that reduce dependence on petroleum fuels in transportation. Asian-Pacific nations that have not adopted these measures need further encouragement to do so.

Renewable electricity capacity worldwide totaled 160 gigawatts (GW) in 2004, excluding large hydro. Developing countries as a group, including China, have 70 GW (44 percent) of the 160 GW total, primarily biomass and small hydro power. The European Union has 57 GW (36 percent), a majority of which is wind power. The top five individual countries are China (37 GW), Germany (20 GW), the United States (20 GW), Spain (10 GW), and Japan (6 GW).

The highest share of investment in renewable energy was in wind power, at roughly $9.5 billion, followed by solar photo voltaic at $7 billion, $4.5 billion for small hydro power, $4 billion for solar hot water/heating, and $5 billion for geothermal and biomass power and heat. Starting from a very small base, renewable energy currently represents 2 percent of energy use worldwide. Globally, renewable energy supplies the equivalent of the residential electricity needs of more than 300 million people.

The key markets for renewable energy today are in the industrialized countries. In 2003, a clear geographical imbalance was evident, with industrialized countries accounting for 92 percent of the wind power installed capacity, and 88 percent of the photo voltaic (PV) cell production. Developing countries as a group, including China, have 70 GW (44 percent) out of 160 GW in total, primarily biomass and small hydro power.

In Asia, the commercialization of biofuels is being accelerated in several countries which have large agricultural populations such as China, India, Japan, Malaysia, the Philippines, and Thailand, partly because of the dramatic increase in oil prices in 2005. Biofuels are of particular interest to island nations that are already suffering high fuel costs because of their small geographic size and the large distances to transport fuels to remote islands. This sector is of great interest to Pakistan both because of its tremendous potential for production and the country's large dependence on imported oil for its transportation and power production needs.

An estimated 16 million households worldwide, including 12 million households in China and 3.7 million households in India, receive energy for lighting and cooking from biogas plants. In biogas, government and non-governmental organization (NGO) supported commercialization through private companies has been a popular approach in Nepal (Biogas Support Program), with more than 140,000 units installed. During the program, 60 private biogas companies increased their technical and market capabilities, 100 micro-credit organizations provided loans, quality standards were adopted, and a permanent market facilitation organization, Biogas Sector Partnership/Nepal, was created. This approach is now being transferred to Vietnam, Cambodia, Laos, and Bangladesh. Biogas plants have been able to bring about significant benefits in quality of life to the users, but less so in terms of bringing about economic gains and poverty reduction. This is another technology of enormous interest and potential in Pakistan.

Small-scale biomass gasification is a growing commercial technology in some developing countries, most notably China and India. In a few Chinese provinces, produce gas from thermal gasifiers provides cooking fuel through piped distribution networks. In the Philippines, gasifiers have been coupled to dual-fuel diesel engines and used for rice-milling and irrigation since the 1980s. Gasifiers have also been demonstrated in Indonesia, Thailand, and Sri Lanka.

Feeding renewable energy into the grid has been spurred primarily by commitments made by a large number of countries in the Asia-Pacific region to meet a certain percent of their power through renewable energy, standard power purchase agreements, and tax incentives in India, China, Nepal, and Sri Lanka. Solar rooftop programs are already popular in the developed countries within the Asia-Pacific region, like Singapore and Japan.

The commercialization models for solar home systems in Sri Lanka, India, and Bangladesh, and the commercialization of the effectively implemented household biogas plants in Nepal consist of a national program that provides market development, quality control and subsidy support. The private sector and NGO partners are allowed to supply systems under certain warranty and quality guidelines. The private sector supplier markets the systems, and the national program routes the subsidy through the supplier. The national programs also provide financing for the purchase of systems. These strategies have been quite successful in terms of expanding markets. However, they have been less effective in terms of increasing energy access to the poor, as the ownership of solar home systems continues to be concentrated among the relatively better off populations of rural communities. In summary, social benefits and quality of life, rather than income and economic benefits, seem to be the key drivers of renewable energy technologies in rural areas.

EXAMPLES OF SUCCESFUL SCALE-UP OF RENEWABLE ENERGY TECHNOLOGIES IN SOUTH ASIA

Grameen Shakti and the Rural Electrification and Renewable Energy Development Program Solar Home Systems Project

The Grameen Shakti (GS) Solar Home Systems Program in Bangladesh sells solar home systems on credit.[8] GS has linked this technology to some income generating activities as well. Individual solar home system capacity ranges from 30 to 128 watt peak power. GS offers several credit modes to fit the various levels of paying capacities of those who want to buy the system on credit. Customers use photo voltaic systems mainly for lighting and for recreational purposes such as watching television. By June 2005, GS had installed 42,000 solar home systems with an installation capacity of 2.15 megawatts.

Grameen Shakti encourages PV users to venture into income-generating activities using their PV systems such as charging of cellular phones, provision of light to post-harvest processing facilities, small enterprises, household-based livelihood activities, and clinics. Such use can extend operations to early evening hours and thus increase daily income. It can also power radio and television repair shops. The project also ventured into the operation of PV-based micro-utilities.

Based on the Grameen Shakti experience, the World Bank and the Global Environment Facility (GEF) launched the Rural Electrification and Renewable Energy Development Program in Bangladesh 2002. Under this program, Infrastructure Development Company Limited (IDCOL), a government-owned finance company, was supposed to disseminate 50,000 solar home systems, and the Rural Electrification Board was supposed to disseminate another 14,000 systems within five years. Solar home systems are financed through micro-financing, with IDCOL providing loans at 6 percent interest through partner organizations for a period of 10 years with a grace period of three years. The project has experienced a great demand for these systems, as a result of which the target was reached by August 2005. The World Bank is providing additional resources to expand this program.

Services Delivery and Renewable Energy Projects in Sri Lanka

The Energy Services Delivery (ESD) project in Sri Lanka, set up in 1997 with assistance from the World Bank and the GEF, promoted financing through banks and micro-finance institutions for private sector provision of on- and off-grid renewable energy services, such as private grid-connected mini-hydro plants, community based off-grid village hydro schemes and solar home systems. It was implemented from 1997 to 2002 with $19.70 credit lines from the International Development Association of the World Bank and a grant from the GEF. Project financing is channeled through the Development Finance Corporation of Ceylon to nine participating credit institutions (PCIs). These PCIs provide credit to hydropower developers and also consumer finance for the purchase of solar home systems.

Based on the success of the ESD project, the Renewable Energy for Rural Economic Development (RERED) project is now in progress. Between them, RERED and ESD have financed a pipeline of around 120 megawatts of small hydropower, roughly 5 percent of the power on the Sri Lankan grid. Some 100 village hydro projects have been installed, and 80,000 solar home systems sold commercially.

Biogas Support Program Nepal

Nepal's Biogas Support Program (BSP) was initiated in 1992 by a joint effort between the Nepalese government and the Netherlands Development Organization, with funding from the Dutch Development Corporation. The subsidy and quality control structure of BSP has succeeded in spurring the industry and leveraging high quality installations and competition among many suppliers. The financial incentives and technical support provided to manufacturers helped increase the number of biogas companies to 57 and the number of biogas appliance manufacturers to 14.

The biogas companies do not only sell, manufacture, and install biogas systems; they also provide after-sales support such as maintenance and repair services. After-sales support is a key element for gaining the confidence of the users. BSP carries out spot checks on up to 15 percent of the plants being built each year to ensure adherence to quality and warranties provided by the companies. This process has also been certified by the International Organization for Standardization's 9000 label, which assures that the biogas plants are operated with internationally consistent, efficient and effective business practices. The BSP report of 2005 states that 11,000 people were employed in this sector at the end of 2004. The Biogas Program had installed more than 140,457 biogas plants in Nepal, as of July 15, 2005. Micro-finance is being provided through three banks and over 100 rural-based micro lending facilities to increase access by the poor.

Renewable Energy Investments in India

India has a separate Ministry of Non-conventional Energy Sources (MNES) dedicated to promoting RETs. The RET dissemination program in India began in the early 1980s, when large dissemination programs for biogas plants and improved cooking stoves were launched, while other RETs such as solar and wind were first introduced as demonstration programs. Since 1992, in tune with the country's economic liberalization policies, MNES has altered its strategy for promoting RETs with a new focus on commercialization. At the same time, large bilateral and multilateral financial assistance was made available through mechanisms like the GEF. Wind power, small hydro power and solar photovoltaic power were the three renewable energies targeted for commercialization under a set of revolving funds created from international financial institutions.

The management of this task was entrusted to the Indian Renewable Energy Development Agency (IREDA), an autonomous financial institution created in 1987 under the MNES. Direct subsidies on various RET programs were either removed or drastically reduced, and several fiscal incentives were provided to users as well as manufacturers. Private entrepreneurs were encouraged to invest in RETs by taking advantage of fiscal benefits such as 100 percent accelerated depreciation, sales tax and import duty exceptions, reasonable buy-back rates, and so on. IREDA provided market development support by conducting marketing campaigns, offering business training, providing various types of credit and subsidies at different parts of the market, and offering other financial incentives. IREDA has invested close to $1 billion since 1987, and has a pipeline of renewable energy investments totaling $1.5 billion. Investments have resulted in the installation of 1200 megawatts of wind energy, 400 megawatts of small hydro, 50 megawatts of solar PV, and 1 million square meters of solar water heaters.

CONCLUSIONS

Continuing high prices of petroleum have further enforced the need for Pakistan to invest in a range of RETs. These are likely to be in the following areas:

Feeding in renewable electricity to the grid

Large amounts of private sector funds can be mobilized for grid-connected renewable energy in Pakistan to meet the current shortfall on the grid and the rapidly increasing demand for power. The favored technology areas will likely be small hydro, wind power, and biomass. Investments will be carried out by private sector independent power producers.

Sustainable development implications of biofuels

Biofuels have gained widespread popularity in a number of agricultural countries due to the recent sustained high prices of petroleum. By contributing to transportation fuels and in some cases power generation, biofuels can reduce the risk Pakistan faces of escalating fossil fuel costs in transportation and electricity, which then translate to an overall increase in inflation rates throughout the economy. Commercial development of biofuels, which was limited to Brazil, has now spread to China, India, and Malaysia. Pakistan has carried out pilots that show tremendous promise for both biodiesel and ethanol to mix into diesel and gasoline.

Commercialization of household energy technologies

Successful commercialization of solar home systems in Sri Lanka and Bangladesh and the commercialization of household biogas plants in Nepal have demonstrated that there is a basic model that works, that can be replicated across borders, and that can offer a variety of household energy technologies to consumers. In its essence this commercialization model consists of a national program that provides subsidy support and quality control and allows private sector or NGO partners to supply systems under a certain warranty and quality guidelines. The private sector supplier will market the systems and make the sale. The national program routes the subsidy through the supplier. In addition to providing the subsidy, the national programs also provide financing for the purchase of systems. In Sri Lanka RERED financing is provided through independent micro-finance organizations. In Bangladesh it is provided to the consumers through the participating NGO in the form of vendor finance and installment payment. Solar home systems and household biogas technologies can be expanded rapidly in Pakistan by replicating the basic business models available in neighboring countries.

Financing

The availability of financing has been shown to boost investment in RETs. Financing is required for the private sector to invest in grid-connected RETs or in ordering a shipment of solar home systems. Donor support has been utilized effectively in many countries by private developers to support market development and trail-blazing costs of early pioneers. These examples are subsequently picked up by the local markets and attract competitors—expanding the market for energy services even more. The rapid growth of grid-connected small hydropower and solar home systems market in Sri Lanka since 1997 and the solar home systems market in Bangladesh since 2003 can both be attributed to their respective World Bank and GEF-funded projects that provided financing to suppliers and project developers. This has been key to the commercialization approach in both countries.

On the consumer side, availability of micro-finance is key for many rural consumers to purchase solar home systems. As the birthplace of micro-finance, Grameen Shakti in Bangladesh offered micro-finance for solar home systems right from the beginning. In Sri Lanka, one of the participating credit institutions under the RERED program is the leading micro-finance agency in Sri Lanka, where solar home systems constitute a remarkable 30 percent of the micro-finance agency's lending portfolio.

Financing will be a constraint for renewable energy investors in Pakistan as the sector grows. Pakistan's Alternative Energy Development

Board needs to work with existing banks and micro-finance institutions to add renewable energy to their repertoire of loan products.

Clean Development Mechanism

The Clean Development Mechanism (CDM) has become fully functional after the ratification of the Kyoto Protocol in February 2005. Renewable energy CDM projects constitute some 17 percent of the pipeline of projects. The rest of the pipeline is dominated by projects which abate industrial gases like hydro-fluorocarbon with extremely high global warming potential, as well as nitrous oxide (N2O) and methane (CH4) from landfill sites, both of which have a high potential for causing global warming. Renewable energy technologies abate relatively modest amounts of greenhouse gases compared to their high upfront costs. However RETs contribute strongly to sustainable development, the other central objective of CDM projects together with greenhouse gas reduction.

The Ministry of Environment, the Designated National Authority, and the Alternative Energy Development Board can play an important role in increasing awareness about CDM as well as in assisting renewable energy investors in Pakistan to take advantage of the RE market. This will help increase the financial IRR (what is IRR?) of projects and make them more attractive to both investors and banks.

NOTES

1. International Energy Agency, "Energy and Poverty," in *World Energy Outlook 2002* (Paris: International Energy Agency and the Organisation for Economic Cooperation and Development, 2002), available from http://www.iea.org/textbase/nppdf/free/2000/weo2002.pdf.

2. Hasna J. Khan and Asma J. Huque, "Solar Photovoltaic in Rural Electrification: Market Assessment Survey in Bangladesh," Energy Research Center/Prokaushali Sangsad Limited, Dhaka, 1998, http://www.nrel.gov/villagepower/vpconference/vp98/Workshop/mpv/khan.pdf.

3. J. Saghir, "The global investment challenge – financing the growth of renewable energies in developing countries," *Renewable Energy World* 8 (2005): 4, 196-211.

4. Christopher Flavin and Molly Hull Aeck, "Energy For Development: The Potential Role of Renewable Energy in Meeting the Millennium Development Goals," paper prepared for the REN21 Network by The Worldwatch Institute,

Washington, D.C., 2005, http://www.ren21.net/pdf/REN21Report%20RETs%20for%20MDGs.pdf.

5. United Nations Development Programme (UNDP), *World Energy Assessment: Overview – 2004 Update* (New York: UNDP, 2004), available from http://www.undp.org/energy/docs/WEAOU_full.pdf.

6. The World Bank Group, *Renewable Energy Development: The role of the World Bank Group* (Washington, D.C.: World Bank, 2004), available from http://siteresources.worldbank.org/INTENERGY/Resources/Renewable_Energy_Brochure.pdf.

7. Bangladesh Renewable Energy Program Information Network, "Solar Energy Programme—Grameen Shakti," 2006, http://www.lged-rein.org/solar/solar_gs.htm.

RESOLVING ENVIRONMENTAL CONFLICTS IN PAKISTAN'S ENERGY POLICY

Saleem H. Ali

"Civilization is in no immediate danger of running out of energy or even just out of oil. But we are running out of the capacity of the environment to absorb energy's impacts without risk of intolerable disruption."

— John Holdren, 2003[1]

A Global Perspective on Energy and Industrial Infrastructure

Pakistan's development predicament is emblematic of many countries that are undergoing rapid growth in energy demand from demographic pressures as well as more intense industrialization. While such growth can certainly be a sign of progress and potentially a means of poverty alleviation, it can also lead to errant euphoria and rash decision-making by policy-makers. At such times of ambition and anxiety, environmental concerns are regrettably relegated to "low politics," and dismissed with pleasantries as short-term gains are calculated on the basis of prestige projects such as large dams and sky-scrapers.

Saleem H. Ali is associate professor of environmental studies at the University of Vermont's Rubenstein School of Natural Resources, and on the adjunct faculty of Brown University's Watson Institute for International Studies. His research focuses on the causes and consequences of environmental conflicts and how ecological factors can promote peace. He is also on the visiting faculty for the United Nations-mandated University for Peace in Costa Rica. In the spring of 2005, he received a two-year grant from the Tiffany Foundation for a comparative study of the environmental and social impact of gemstone mining in Madagascar, Brazil and Myanmar. He is the author of *Mining, the Environment and Indigenous Development Conflicts*.

Bursts of infrastructure development require enormous amounts of energy, and without careful planning such efforts can leave countries resource-depleted without much economic gain. The fate of capitals such as Abidjan or Buenos Aires that might boast impressive buildings and roads but distressed local economies must be considered by the infrastructure enthusiasts. Similarly, enormous energy capacity projects such as the Caborra Bassa dam in Mozambique reflect how infrastructure without adequate environmental planning and a resolution of indigenous conflicts can deteriorate and become more of a liability than an asset.[2]

Even in China, which is often considered the hallmark of rapid industrial development in Asia, the connection between environmental damage and long-term economic decline is now being considered by the government. On April 16, 2006, President Hu Jintao made an alarming admission that China is perhaps growing too fast at the expense of its environment. The statement was made during a meeting with former Taiwanese opposition leader Lien Chan, as they discussed prospects for peace in the region. While many Pakistani policy-makers often talk about emulating mainland China's development path, perhaps there are many lessons that they might instead learn from Taiwan in terms of a relatively green growth.

A composite environmental performance index developed by Yale University's Center for Environmental Law and Policy ranked Taiwan two scores ahead of the United States in its environmental performance. China scored 70 ranks below Taiwan. Pakistan, India and Bangladesh were all in the lowest quartile, largely due to poor air quality indicators that are linked to their energy policies. Sri Lanka and Nepal faired slightly better on account of better environmental health indicators, but still far below environmentally progressive countries such as Malaysia and Costa Rica, which were in the top quartile.[3]

Taiwan has managed to accomplish growth despite a very large defense budget, which is often the excuse for slow development by countries like Pakistan. While the country's economic and environmental performance might have been even better without its massive arms purchases, at least the island state has managed to follow a positive development trajectory. Studies by the Chinese government have shown that asymmetry of development and environmental decline are causing economic losses. One such study cited by the New China News Agency says the country's western provinces will suffer an annual loss of 15 billion euros, or 13 percent of the region's GDP, due to environmental damages. President Hu Jintao's statement reflects a realization of these economic consequences.[4]

Keeping in view such global comparative perspectives, it is critically important that Pakistan's energy policy develop its resources with vigilant care for ecological indicators. This essay attempts to highlight some of the ways ecological planning criteria should be considered in formulating energy policy. Instituting appropriate accounting systems for energy demand and supply must be a first step, followed by national efforts to tackle inefficiencies in energy generation and distribution. Large infrastructure projects for energy supply should only be considered as a last resort after low-cost conservation measures have been fully expended.

AN ECOLOGICAL CRITIQUE OF PAKISTAN'S ENERGY POLICY

The most fundamental concern with Pakistan's current energy policy trajectory stems from how success is being defined by the government. There is a perception that somehow reaching the country's energy extraction potential is necessarily a positive indicator of development. Such definitional mistakes have led to major environmental policy concerns in previous years. For example, during the early decades of the twentieth century the Bureau of Reclamation in the United States defined "conservation" of resources as harnessing every kilowatt of energy that flowed through a river. There was a perception that not harnessing such energy and letting the water flow to the ocean was "wastage." The bureau has since realized that conservation is not synonymous with extraction but rather efficient use of resources with minimal impact on the systems that sustain those resources in the first place.

A list of the key metrics that appear to be misleading energy policymakers in Pakistan would include the following:

Low Per Capita Consumption

The use of unrefined macro-indicator planning is pervasive in Pakistan, as the nation continues to consider consumption as a direct indicator of economic success. While there may be some correlation between higher consumption and industrial success, using this as a metric creates perverse incentives for excessive energy usage that might even be wasted. Therefore, in benchmarking performance against regional economic competitors, the use of "per capita consumption" is highly misleading. Indeed, if per capita consumption is low, that could also be considered a measure of success in terms of efficiency of processes. For example, Morocco has a lower per capita energy consumption of 372 kilograms of oil equivalent per person per year (kgoe) than Pakistan's metric of 471(kgoe).[5] However, Morocco has a better performance than Pakistan on the human development index as well as in terms of industrialization indicators. Instead of using consumption as a metric of success, development indicators in terms of industrial output per units of investment should be used as metrics of success to prevent errant policies that artificially increase consumption from taking root.

Efficiency Defined as Units of Energy Per GDP

Aggregate economic metrics such as the gross domestic product (GDP) are useful to some degree in providing a very rough assessment of economic activity in a country. However, the use of such indicators for benchmarking energy policy can again lead to skewed outcomes. For example, the Pakistani government continues to define efficiency of energy, also referred to as energy intensity, in terms of energy input divided by GDP, when most countries have moved to more refined measures that take into account the climate and sectoral mix of the country in question. For example, countries in extreme climates may have a much higher energy intensity due to energy consumption for heating or air conditioning. At the same time, some countries may have a much higher contribution of the service sector than of high-energy industry in promoting GDP, which would lead to low energy intensity. The ultimate policy goal from an environmental perspective should be to achieve a mix of low energy-intensive economic growth sectors. A measurement of efficiency should be based on an evaluation of how much energy is being used to produce a given industrial output or useful end product, such as lumens of light for domestic use, and how much is being lost or wasted.

Supply-side Policies Driven by GDP Growth Targets

The aforementioned metrics of energy ultimately lead to a set of policies that have tunnel vision towards economic growth without considering whether such growth is sustainable. To make matters worse, GDP growth targets are set and then existing energy usage ratios are used to calculate what amount of energy would be required to meet those growth targets. In one set of scenarios developed for the government, conservation was the last policy scenario considered, in which a modest 9 percent reduction through reduced demand and 15 percent technical savings for power generation were assumed.[6] However, there is little attempt by policymakers to focus on how demand might be altered and made more efficient to meet the existing supply constraints. This supply-side approach stifles innovation towards environmental consciousness or energy conservation while leading to massive investments in new energy generation capacity at the expense of ecological factors.

Skewed Cost-Benefit Analyses

Policymakers are often presented cost-benefit analysis in a stylized objective fashion when in fact the embedded assumption in such analyses can reveal enormous inconsistencies and a departure from ecological constraints. For example, the use of high discount rates to calculate the benefits of environmentally beneficial projects such as solar and wind may render them uncompetitive in terms of cost even if they are likely to be more secure in the long-run.

Also, there are assumptions about energy imports being more expensive than domestic production because of existing regulatory constraints. However, if the cost of production, including environmental impact are calculated, imports will not necessarily be more expensive than domestic production. This is clearly the case with natural gas imports from Central Asia being more economical as well as having much less aggregate environmental impact in project development and air pollution concerns than local coal mines. While the security of energy supplies is a vital argument against imports, geopolitical circumstances are moving towards greater interdependence among countries on matters of energy, as discussed later in this essay.

THE PERIL OF PRESTIGE IN NUCLEAR POWER

The cost-benefit analyses with regard to fuel cost for nuclear energy is particularly troubling. In most cases, the capital costs are the major component of such analysis whereas operating and maintenance costs and fuel costs are frequently underestimated. The price of uranium fuel can fluctuate dramatically as we can see from observing the past five years of the price of uranium oxide, which was around U.S. $6 per pound in 2001 and has jumped to over $40 per pound in 2006.[7] Furthermore the cost of appropriate disposal of nuclear wastes is frequently neglected. While reprocessing is often presented as an alternative, in reality reprocessing does not reduce waste, as it can only reduce the amount of mined uranium. France, among the world's leading nuclear energy users, spends about $1 billion more per year on reprocessed plutonium fuel compared to uranium fuel.[8] Even the relatively promising thorium reactors, for which India has the second-largest ore reserves of monazite in the world, first require the thorium to be converted to fissionable uranium.

Plutonium fuel obtained by reprocessing (also called mixed-oxide fuel or MOX) is two to three times more costly than uranium fuel. Apart from the prestige of being a nuclear energy producer, increased investment in nuclear power makes little economic sense. By playing around with discount rates, proponents of nuclear energy can sometimes come up with ostensibly cost-effective comparisons with other fuels. However, there is little doubt that the construction cost of a nuclear power plant is inordinately more than any other source. In a recent study by the Massachusetts Institute of Technology, the all-inclusive cost for a nuclear power plant operating over 40 years is 6.7 cents per kilowatt-hour, which is almost twice the cost for natural gas at current prices.[9]

These arguments bode negatively for nuclear energy even without considering its environmental and human health impact. Nuclear energy is also not very reliable at this stage since plant upgrades can take years to accomplish. For example, Pakistan's only nuclear generator, the Karachi Nuclear Power Plant (KANUPP), was shut down for refurbishment in December 2002 after exhausting its 30-year design life and is still undergoing upgrades before being ready to reach capacity again. The environmental challenges of managing radioactive mining have become evident by the recent case of the village of Baghhalchur in rural

Punjab, Pakistan. From 1978 to 2000 this region provided the Pakistani Atomic Energy Commission (PAEC) with yellow cake for the country's nuclear program. The half a million tribesmen in this region near Dera Ghazi Khan, many of whom are of Baluchi ethnicity, have leukemia rates that are six times the national average. Even former employees of PAEC, such as Professor Khalid Rashid of Bahria University, have publicly acknowledged that there are legitimate concerns of radioactive pollution that need to be investigated.[10] In a rare show of support for environmental enforcement, the Pakistani supreme court agreed to hear the petitions of the residents of the area in March, 2006, and a decision is pending.

The ostensible benefit of nuclear energy in terms of reduced greenhouse gas emissions is also misleading, since the energy required to mine uranium and the maintenance of reactors shows that there is indeed a net contribution of greenhouse gases from nuclear energy as well.[11] While Pakistan and all other countries should keep the nuclear option open, it must always be a last resort and probably requires several more decades of research on waste management solutions and cost efficiency before being viable on a large scale.

HUMBLING THE HYSTERIA OVER HYDROPOWER

The prestige factor with large-scale hydropower also appears to be resonating with the Pakistani government. While the advantages of dams such as Tarbela and Mangla at the time of construction are widely appreciated, the long-term viability of these projects remains questionable. In its case study on Tarbela dam, the World Commission on Dams generally concluded that the dam had made a positive contribution to the Pakistani economy, particularly the energy sector. However, what is less clear is whether the dam and other such large irreversible hydropower projects can sustain benefits over the long-run in comparison with alternative energy sources. The useful life of a dam such as Tarbela is about 100 years, for which approximately 100,000 people were displaced, not to mention the inundation of 23,000 hectares of arable land. Even the increase in cultivable land requires further ecological study in cost-benefit analyses, since in many cases mismanagement of the irrigation schemes led to salinity and water-logging, and an eventual loss of arable capacity in 22 percent of the Indus basin.[12] Evaporation losses can greatly diminish irrigation benefits as well. The flood control advantage of dams must be balanced with the risk of dam failure in high risk zones.

Seismic hazards and the vulnerability of such sources in times of armed conflict and droughts need to be of particular consideration following the Kashmir earthquake of October 2005. The vulnerability of dams to earthquakes remains considerably high throughout this region, as exemplified by numerous studies of faults in the area.[13] A large dam failure can be utterly catastrophic as illustrated by China's experience with the collapse of the Banqiao reservoir dam in 1975, which killed over 175,000 people and displaced 11 million residents. Even though China is proceeding with the Three Gorges project on the Yangtze river, despite the refusal of the World Bank to fund it, the Chinese are having second thoughts about some of their other dam projects including a moratorium on 13 proposed dams on the Nu River.[14]

Indeed, even the positive impacts of reduced greenhouse gas emissions of large dams is being questioned, since there is potential for methane generation from dam reservoirs. It is for this reason that dams above ten MW of generating capacity were initially excluded from the list of eligible renewable energy sources presented by the European Union to the Intergovernmental Panel on Climate Change in 2000. While this list was subsequently not accepted by all countries, the World Bank has admitted that hydropower projects greater than ten MW have "declining commitments" from the international community.[15] It is thus alarming that the Pakistani government is now considering five new large hydropower projects. The Bhasha (Diamir) dam, whose construction has already been inaugurated by President Musharraf, would be comparable in MW capacity to Tarbela at around 3500 MW. Extensive community opposition is already palpable around this project, reminiscent of earlier concerns over the Kalabagh dam, and there are growing concerns that the conflicts at the micro-level as well as distributional concerns between provinces may further destabilize the country.[16]

As compared to large-scale hydropower, small-scale hydropower is a highly attractive renewable solution and must be encouraged across Pakistan. Such dams have the advantage of being more flexible to engineering redesign, or removal if necessary, as they age. There are indeed promising possibilities in this regard for smaller rivers across Pakistan such as the Kunhar, the Swat, and Chitral. While aggregate hydropower capacity from these rivers might not ostensibly match the potential from large projects, the overall efficiency in distribution systems can often make them more attractive.[17] There is much to be gained from pursuing a sensible policy on hydropower so long as we remember that "bigger is not always better."

An Agenda for Change

Despite the grim critique in this paper, there are some relatively quick policy interventions and compliance measures which can be undertaken to improve Pakistan's energy prospects. The country has adequate human and natural resources to meet these demands for the foreseeable future. As relations improve with its neighbors and in regional security, the long-term outlook can indeed be very positive as the following measures are considered domestically:

Auditing Energy Consumption

The first step to solving any technical problem is to have a better estimate of the status quo. At present there is hardly any data available on the energy performance of Pakistan's industry. Therefore a detailed audit of industries and households in urban and rural areas is needed. A modest study of energy conservation potential including audits was performed by the government in the late eighties, and included industrial units, residential and commercial buildings and appliances, turbines and tractors in agriculture, and passenger and freight vehicles. Apparently there is renewed interest from the Asian Development Bank and the German development agency (GTZ) in revising this study, which should subsequently be an important tool for energy policy-makers in Pakistan.[18]

Individual studies of energy consumption, particularly in rural areas of Pakistan, have revealed some counterintuitive insights which the government might also consider. For example, one doctoral study of rural energy consumption in Punjab found that electricity is only used for lighting, which is a negligible proportion of the total household energy consumption, and the researcher concluded that "a route of supply side energy policy that only encourages increasing the supply of energy resources, is most often based on inaccuracies and extrapolations of past growth or historic elasticity of energy supply."[19] Food preparation, water heating and animal-warming are main demand areas in rural areas and traditional fuels continue to be preferentially used even when grid power is made available. Some of these fuels may indeed be very problematic when used in crude form, such as dung, but quite feasible with small technological innovations that filter out pollutants such as inexpensive "clean" stoves that have been used in Mexico and China.[20] A comprehensive energy audit would reveal the details necessary to implement such technological efforts and provide more effective and targeted solutions.

Conservation Pricing and Enforcement

Creating proper economic incentives to ensure conservation behavior on the part of consumers is an essential ingredient to effective energy policy. There needs to be an effective enforcement system for energy usage to prevent theft and "free riding" of the system. The government has begun to enforce laws against such thefts, but considerably more compliance assurance is needed through police action and prosecution where necessary.

Furthermore, recent analysis conducted at the Lahore University of Management Sciences has revealed that there is inefficient allocation in Pakistan's manufacturing sector, characterized by "the absence of equality between marginal rates of substitution and factor price rations."[21] In other words, the pricing of energy in Pakistan's manufacturing sector is leading firms to use resources inefficiently. Ensuring that such pricing concerns are addressed will reduce the load on the system considerably, and will be a win-win solution for both industry and the creation of a more dependable energy supply.

Using Technology to Overcome Losses in the System

By one estimate of Pakistan's private energy systems, thermal efficiency in energy generation systems tends to be around 32–35 percent when the global average is around 54 percent.[22] We could thus have a 60 percent improvement in energy generation by simply switching to newer production technologies. Distribution losses in these systems tend to be around 23 percent, whereas the technical losses should be no more than

3 percent. By this estimate, Pakistan could increase its energy availability by a staggering 80 percent simply through more efficient distribution systems that could be updated at a fraction of the cost of mega-energy generation projects being proposed.

Furthermore, these numbers do not even account for energy conservation measures in buildings and factories that would result from proper energy audits across sectors mentioned earlier. There are some glimmers of hope in the improvement of energy efficiency through more effective harnessing of biofuels as revealed by one comparative study of the region which compared Pakistan, India, Bangladesh and Thailand.[23] Indeed there are many lessons on efficient technological applications, specially at the rural scale, which can be gleaned from such comparisons.

Giving Precedence to Renewable Sources

Apart from natural gas, there is tremendous potential for wind and solar energy across South Asia that has hardly been explored. With funding from the Asian Development Bank, Pakistan's government has set a target of generating 10 percent of its electricity needs using renewable energy resources (approximately 2,700 MW) by 2015. The government has established an Alternative Energy Development Board (AEDB) and will launch a Renewable Energy Project that will invest in developing electricity sources for rural areas.

There is tremendous potential for wind and solar energy across South Asia that has hardly been explored. According to Winrock International, less than 10 percent of India's estimated wind energy generation potential of 45,000 MW has been harnessed so far. Solar energy potential—an estimated 300 days per year of full solar exposure in many areas of the country—is enormous as well.[24] While the Pakistani government has started to develop some wind and solar projects in Sindh and Baluchistan as highlighted by Bikash Pandey in this volume, these projects continue to be relegated to the periphery rather than being given precedence over the larger infrastructure projects.

Mining with Maturity

There has also been a renewed interest in mining coal in Pakistan. While coal is abundant in Baluchistan and parts of Sindh, the quality of the deposits is a matter of great concern. The contribution of coal to Pakistan's electricity generation has declined from 60 percent in 1947 to 8 percent currently, but this should not be a cause for lament by the government. Some high quality coal deposits when harnessed with appropriate technologies are indeed viable. However, there must first be appropriate regulatory safeguards for safety and health in mining the coal, as well as protection for sensitive ecological areas such as Kirthar National Park.[25] At present Pakistan has not been part of numerous industry-wide efforts to improve the performance of the mining sector such as those launched by the World Business Council on Sustainable Development. Any new mining projects must adhere to such standards before being rushed through for approval.

HUMAN SECURITY VERSUS SECURING ENERGY RESOURCES

Since much of Pakistan's minerals are in the sparsely populated province of Baluchistan or in the highly heterogeneous province of Sindh, there are serious concerns about asymmetric development and benefit trajectories for the country. While it may be considered environmentally fortuitous that the mineral reserves of the country are in a region of lower population density to mitigate aggregate risk, the negative differential distribution of benefits to Baluchis from the minerals has led to serious grievances.[26] Instead of making the minerals appear as a distributive conflict in Baluchistan or Sindh provinces, the government should use the revenues being generated as a means of addressing the economic disparities that exist in the provinces. Such disparities cannot be alleviated simply by large infrastructure but rather through educational capacity-building for the Baluch to ensure employment security in the long-term. Otherwise, there is a danger of capital flight and a continuation of asymmetric development.

Contrary to common perception, mining companies are often willing to operate in politically insecure locations so long as the government is supportive of their economic interests. Unlike other industrial sectors, the location of a mine is determined by geology far more than by individual choice. Resource companies are more afraid of nationalization and uncompetitive government behavior than of ethnic tensions. When queried at a recent shareholder meeting about the $100 million investment that Barrick Gold has made in the Reko Diq copper-gold mine in

Baluchistan in spite of ethnic tensions, the CEO Peter Munk responded: "If I had my choice between dealing with (Venezuelan President Hugo) Chavez, or (Bolivian president Evo) Morales, or Aziz (the Pakistani prime minister), I know where I would put my money."[27]

However, it is important that the government not abuse this complacence to ethnic strife on the part of mineral investors, since the government will eventually have to spend enormous amounts of money for security, which could be avoided by constructive engagement with the community. Furthermore, the demands of the indigenous Baluchis must not be conflated with the insurrection of tribal elites such as Nawab Bugti.

The energy factor should also be used as a means of fostering cooperation not only between provinces but also regionally between South and Central Asia. The proposals for various gas pipelines have the potential not only to provide relatively clean and environmentally manageable energy to the region, but also to foster cooperation.[28] Interdependence is an attractive incentive for cooperation. Nevertheless, in this case, political stability is far more consequential to success than to individual mines. The potential for sabotage along pipelines can paralyze projects, and thus, constructive engagement with all players is essential to the success of these projects. There are lessons in pipeline project management which Pakistan can learn from recent projects such as the Baku-Tblisi-Ceyhan pipeline from Azerbaijan to Turkey via Georgia. In that case, there were environmental challenges that led to conflicts while the political negotiations brought the countries closer.[29] A willingness to engage with communities and stakeholders, even if this may delay the project, as well as political compromise between countries must occur simultaneously for such projects to succeed. However, if appropriately managed they can indeed lead to greater cooperation and stability.

CONCLUSION

Pakistan has tremendous potential for having a sustainable energy policy, if appropriate planning measures are put in place. However, the current development trajectory that the government is pursuing raises serious ecological concerns which inevitably translate into impaired development in the long-term. The first step towards an environmentally conscious energy policy would be to have a nation-wide audit of current inefficiencies in the generation and distribution system for power. This must be followed by appropriate pricing and compliance enforcement to prevent losses and perverse incentives for wastage of energy. Once these conservation matters have been addressed, the remaining shortfalls should first be met with plans for expansion of renewable sources, primarily wind, solar, biomass and small-scale hydroelectric. Large hydroelectric generation projects should only be considered after the guidelines enunciated by the World Commission on Dams have been followed, rather than hastily pushing forward such projects under the banner of national pride or patriotism.

Research on environmentally safe ways of harnessing nuclear energy and disposing of radioactive wastes should continue. However, the current expansion of nuclear energy installation capacity should be a last resort. This argument is premised not only on ecological concerns but also on economic factors. Trans-boundary gas pipeline projects have the potential for augmenting Pakistan's energy prospects while also fostering regional cooperation. Following lessons of similar projects elsewhere with which the World Bank has considerable experience, Pakistan can gain cost-effective sources of natural gas. However, these efforts must be undertaken with special reference to prioritizing benefits for the indigenous populations of the Sindh and Baluchistan provinces. Short-term planning on energy policy in Pakistan will encourage rash decisions that might lead to a decline in economic growth as well as in the environment. Conversely, human security and environmental risk management, coupled with a long-term approach to energy planning, can sustain the enviable economic growth rates that we are witnessing today.

NOTES

1. John Holdren, "The Quest for Affordable Energy," review of Vijay Vaitheeswaran's *Power to the People: How the coming energy revolution will transform an industry, change our lives and maybe even save the planet, Scientific American* (December 2003).

2. For an academic inquiry into how grand infrastructure projects can fail, see Sir Peter Hall, *Great Planning Disasters (*Berkeley: University of California Press, 1982).

3. World Economic Forum, Davos, Switzerland, "Pilot Environmental Performance Index," January 2006, http://www.yale.edu/epi/.

4. Brice Pedroletti, "En Chine, le déficit de politique écologique menace les performances économiques," *Le* Monde, July 2, 2005; and Saleem H. Ali, "In China globalization can be green," *International Herald Tribune*, May 30, 2006, http://www.iht.com/articles/2006/05/30/opinion/edali.php.

5. World Resources Institute, "Earthtrends," 2006, http://www.earthtrends.wri.org

6. See the essay by Mukhtar Ahmed in this volume for more detail on these scenarios.

7. The World Nuclear Organization, "Uranium prices," 2006, http://www.world-nuclear.org.

8. Arun Makhijani, "Disposal of radioactive waste in France: a readiness to harm," *Institute for Energy and Environmental Research* 13 (2005): 4.

9. John Deutch, et. al., "The Future of Nuclear Power" (Cambridge, MA: Massachusetts Institute of Technology and Harvard University, 2003), http://web.mit.edu/nuclearpower.

10. Zofeen Ebrahim, "Pakistan villagers pay the price of nuclear ambitions," *Inter Press Service*, May 31, 2006, http://www.newsdesk.org/archives/000711.php.

11. Brice Smith, *Insurmountable Risks: The dangers of using nuclear power to combat climate change* (Washington DC: Institute for Energy and Environmental Research (IEER) Press, July 2006).

12. Asianics Agro-Dev. International Private Limited, *Report on the Tarbela Dam to the World Commission on Dams* (Islamabad: Asianics Agro-Dev Press, 2000).

13. Roger Bilham, "Dangerous Tectonics, Fragile Buildings and Tough Decisions," *Science* 311 (March 2006); and Roger Bilham et. al., "Himalayan Seismic Hazard," *Science* 293 (August 2001).

14. Jennifer Turner and Lu Zhi, "Building a Green civil society in China," in *State of the World 2006 (*New York: WW Norton Press, 2006); and China Environment Forum, Woodrow Wilson International Center for Scholars, http://www.wilsoncenter.org/cef/.

15. World Bank Group, *Progress on Renewable Energy and Energy Efficiency* (Washington, D.C.: World Bank Press, 2005).

16. Alok Bansal, "Kalabagh: The General Retreat," *Peace and Conflict* 9 (2006): 3.

17. Simon Taylor, et. al., "Flowing to the East: Small hydro in developing countries," *Renewable Energy World* 9 (2006): 2; and International Network on Small Hydropower, http://www.inshp.org. Pakistan is still not a member of the International Energy Agency's "Small-scale hydro agreement," http://www.small-hydro.com.

18. Vaqar Zakaria and Hagler Bailly, consultants, email communication with author, Islamabad, Pakistan, July 13, 2006.

19. Mohammed Abdur Rabb, "Household energy demand in South Asia: An approach towards discrete/continuous models" (Ph.D. diss., University of Texas at

Dallas, 2001).

20. For details on some of these technologies, refer to the Household Environmental Monitoring Lab at the University of California, Berkeley, http://ehs.sph.berkeley.edu/hem/; United Nations Development Program (UNDP) also launched a program for fuel-efficient smokeless stoves in Pakistan several years ago with considerable success, http://sgp.undp.org/download/SGP_Pakistan1.pdf.

21. Abid A. Burki and Mahmood-ul-Hasan Khan, "Effects of allocative inefficiency on resource allocation and energy substitution in Pakistan's manufacturing," *Energy Economics* 26 (2004): 371-388.

22. See Asad Umar's contribution in this volume for additional detail.

23. J.W Sun and E. Kuntsi, "Environmental impact of energy use in Bangladesh, India, Pakistan and Thailand," *Global Environmental Change* 14 (2004): 161-169.

24. For further details on renewable energy projects in India see http://www.renewingindia.org/.

25. World Conservation Union (IUCN), *Status Paper on Minerals and Mining in Sindh* (Karachi: IUCN Press, 2001).

26. Frédéric Grare, "Pakistan: The Resurgence of Baluch Nationalism," (Washington, D.C.: Carnegie Endowment for International Peace, 2006),

27 http://www.carnegieendowment.org/publications/index.cfm?fa=view&id=17865&prog=zgp&proj=zsa.

Lisa Wright, "Bolivia alarms mining giant," *Toronto Star,* May 5, 2006, http://www.thestar.com.

28. Toufiq Siddiqi, *Enhancing Clean Energy Supply for Development: A Natural Gas Pipeline For India and Pakistan,* (New Delhi: Balusa Press, 2003).

29. S. Frederic Starr and Svante E. Cornell, *The Baku-Tblisi-Ceyhan Pipeline: Oil Window to the West,* (Washington DC: Central Asia-Caucus Institute, Johns Hopkins University, 2005).

RECENT ASIA PROGRAM PUBLICATIONS

Pakistan Program Publications

Education Reform in Pakistan: Building for the Future
Shahid Javed Burki, Christopher Candland, Grace Clark, Ishrat Husain, International Crisis Group, Jonathan Mitchell, Salman Humayun, Irfan Muzaffar, Tariq Rahman, Michelle Riboud, Ahsan Saleem, Salman Shah, United States Agency for International Development, World Bank (South Asia Human Development Department), 2005

Islamization and the Pakistani Economy
Khurshid Ahmad, Shahid Javed Burki, Isobel Coleman, Parvez Hasan, Vali Nasr, Omar Noman, Ishrat Husain, Charles Kennedy, Saeed Shafqat, 2004

Asia Program Publications

Special Report No. 135 – The Chinese People's Liberation Army: Should the United States Be Worried?
Dennis J. Blasko, Bernard D. Cole, Kristen A. Gunness, Litai Xue, December 2006

Special Report No. 134 – Six-Party Stall: Are South Korea and China Part of the Problem or Part of the Solution?
Kerry Dumbaugh, Kirk W. Larsen, Sung-Yoon Lee, Bojiang Yang, November 2006

Special Report No. 133 – The Avian Flu Challenge in Southeast Asia: The Potential of Public-Private Parnership
Tjandra Yoga Aditama, Peter R. Gourlay, David Reddy, Tracy S. DuVernoy, September 2006

Special Report No. 132 – Edging Toward Full Empowerment? South Korean Women in the Workplace and the Political Arena
R. Darcy, Seungsook Moon, Kyung-ae Park, Jean R. Renshaw, September 2006

Special Report No. 131 – China and Democracy: A Contradiction in Terms?
Richard Baum, Merle Goldman, Suisheng Zhao, Yongming Zhou, June 2006

Special Report No. 130 – One Year After the Tsunami: Policy and Public Perceptions
Roberta Cohen, Bambang Harymurti, Muhammad Qodari, Courtland Robinson, May 2006

Japanese Women: Lineage and Legacies
Margarita Estévez-Abe, Takashi Fujitani, Barbara Molony, Hitomi Tonomura, Chikako Usui, Merry White, October 2005

Special Report No. 129 – China's Economy: Retrospect and Prospect
Franklin Allen, Loren Brandt, Lee Branstetteer, Donald Clarke, Chang-tai Hsieh, Jikun Huang, Yasheng Huang, Nicholas Lardy, Peter Murrell, Barry Naughton, Jun Qian, Meijun Qian, Thomas G. Rawski, Scott Rozelle, Susan Whiting, Xiaodong Zhu, July 2005

Seabed Petroleum in Northeast Asia: Conflict or Cooperation?
Selig S. Harrison, Zhiguo Gao, Kim Myong Gil, Zhao Li Guo, Keun Wook Paik, Choon-Ho Park, Zhang Hai Qi, Kook-Sun Shin, Jilu Wu, Susumu Yarita, 2005

George W. Bush and East Asia: A First Term Assessment
Richard W. Baker, Chan Heng Chee, Catharin E. Dalpino, Evelyn Goh, Harry Harding, Jia Qingguo, James A. Kelly, Ilsu Kim, James A. Leach, Koji Murata, Jonathan D. Pollack, Robert Sutter, Nancy Bernkopf Tucker, Jusuf Wanandi, 2005

Special Report No. 128 – Japanese ODA at 50: An Assessment
Saori N. Katada, Juichi Inada, David Leheny, Yoshio Okubo, February 2005

Special Report No. 127 – "An Imperfect Country of Great Consequence":Indonesia and the Challenge of Global Terrorism
Ali Alatas, J. Stapleton Roy, January 2005

Special Report No. 126 – China's "Good Neighbor" Diplomacy: A Wolf in Sheep's Clothing?
John W. Garver, Dennis V. Hickey, Michael R. Chambers, January 2005

Special Report No. 125 – Taiwan's Constitutional Reform: Domestic Inspiration and External Constraints
Jiunn-rong Yeh, Jacques deLisle, Alan M. Wachman, November 2004

Special Report No. 124 – Active Society in Formation: Environmentalism, Labor and the Underworld in China
Guobin Yang, Ching Kwan Lee, Ming Xia, September 2004

Special Report No. 123 – A Billion Ballots for Democracy: Election Year in Indonesia
Meidyatama Suryodiningrat, Muhammad Qodari, Jim Della-Giacoma, August 2004

* * * *

A copy of any publication can be obtained free of charge by visiting the Asia Program online at http://www.wilsoncenter.org/asia. A more complete list of Asia Program publications may also be found online.

The Woodrow Wilson Center Asia Program
One Woodrow Wilson Plaza
1300 Pennsylvania Avenue, NW
Washington, DC 20004-3027
Ph: 202-691-4020 Fax: 202-691-4058
Email: asia@wilsoncenter.org
www.wilsoncenter.org